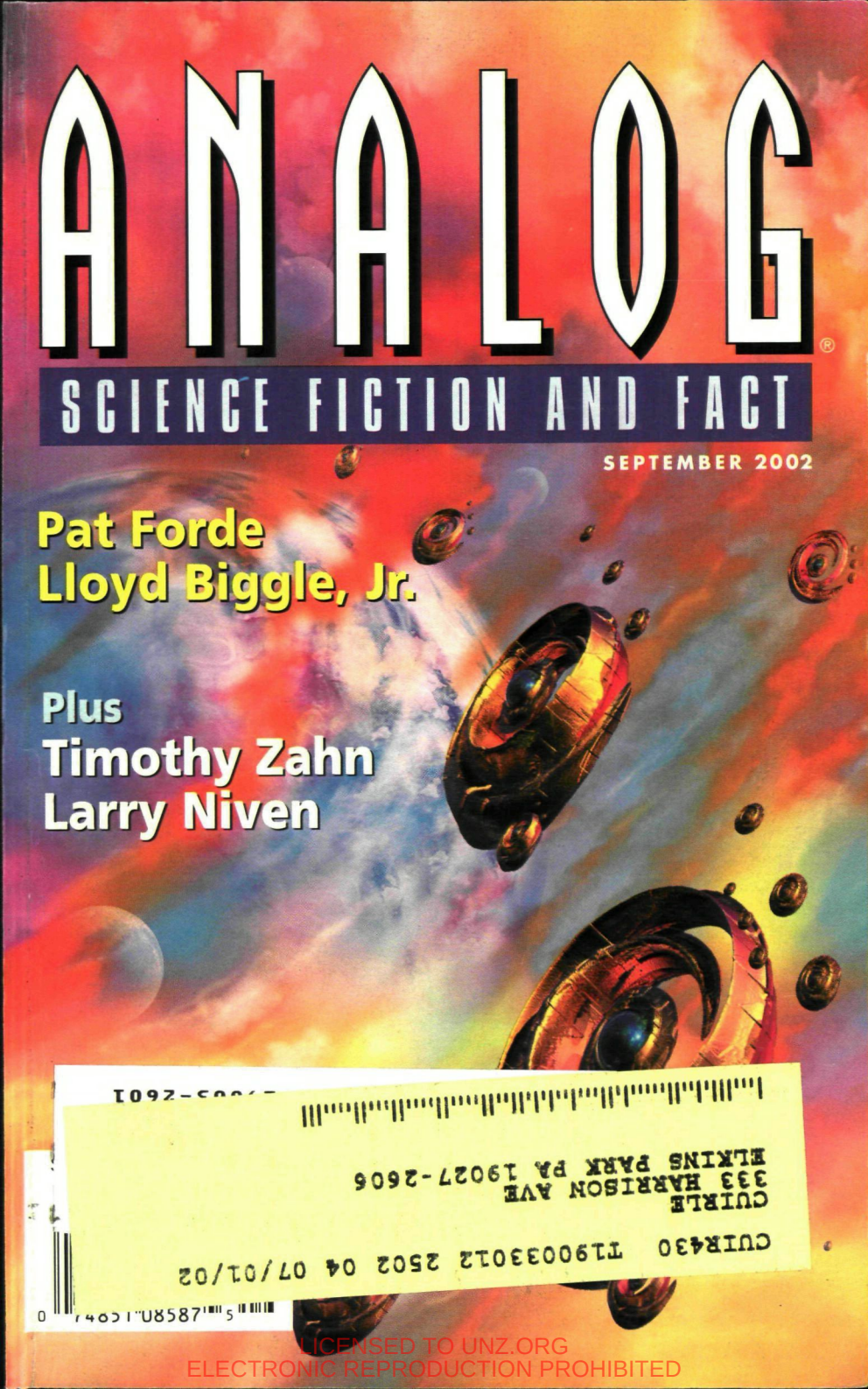

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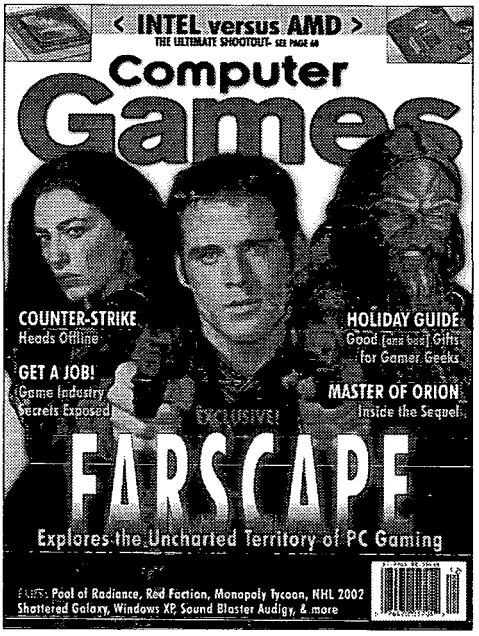
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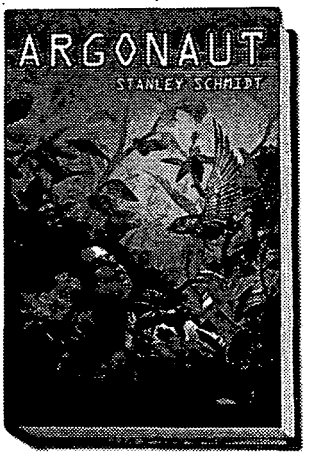

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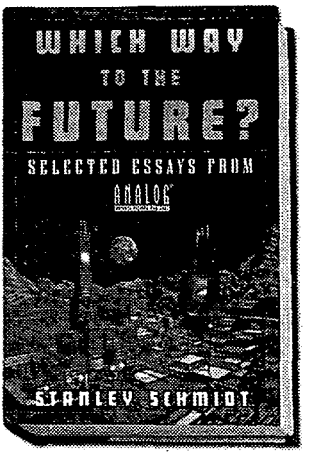

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EDITORIAL Stanley Schmidt

FLAWED EXPERIMENT

You'll probably be reading this near the beginning of a new school year, which seems like an excellent time to reexamine some very basic points of educational philosophy. Like: Just what are we trying to accomplish with education, how do we judge how well it's working, and how can we make it better?

A big controversy involving all three of those questions has been stewing in New York State for the last couple of years. It seems to me (as an educator who doesn't happen to be working in a classroom now, but has done so in other years) that the educational Powers That Be are not doing very well on this test. And tests, as it turns out, are the focal point of the controversy.

One of the latest educational fads hereabouts is a vigorous push for "higher standards," which, on the face of it, sounds like a Good Thing indeed. As one who has taught college students, and had to deal with the glaringly inadequate preparation some of them had in such basic areas as math, English, and science, I could hardly avoid applauding any program that would improve that situation.

But please note that I said any program that *would* improve the situation—not just any that said it was *intended* to improve it. So the acid test is: Will the proposed changes work? Results, not just good intentions, count.

Ironically, that's exactly the principle the proponents of the changes say they want to apply to students. They want to make sure that a high-school diploma proves not just that a graduate occupied space in a high school for a certain period of time, but that he or she achieved at least a certain degree of learning. Again, a commendable goal; but the commendability of their proposal for achieving it is less clear.

Their solution is this: Make it a basic requirement for graduation that all students must pass the Regents exams in several fields. These are standardized tests offered by the state to measure a fairly high level of achievement, until recently widely used in support of college admission applications but not required for graduation from high school. Many graduates will not go to college, but even they now have to pass Regents exams in English and math with a score of at least 55 percent. More requirements are being phased in over the next couple of years. Eventually everybody will have to pass these tests in not only English and math, but also U.S. history, "global studies," and science—each with a score of 65 percent.

Far be it from me to deny that most people need to know more about all these things; I've often said so myself. What I question is whether the problem is being approached in a meaningful way, and whether the actual effects of the proposed remedies will be more beneficial than harmful.

Let me get this straight: The problem is that not enough students are passing the tests they're already subjected to (of which there are quite a few). The solution is to demand that they pass even more and harder tests?

I hope I'm not the only one struck by the sheer inanity of this reasoning,

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when it's summarized that baldly. It seems to me that those who are pushing this "solution" have lost sight of the distinction between a developmental process and a measurement of the results. Despite the platitude that some teachers perpetuate, a test is very seldom actually a learning experience, at least as far as its subject matter is concerned. It's more like a trial by ordeal. The only educational value it might have is as a motivator, "inspiring" people to apply some concentration to the subject at hand by evoking fear of the consequences of failure.

I seriously question whether fear is the best possible motivator. Good teachers can and should do much better. We already have way too many students dreading any sort of intellectual activity. Putting them through still more fear-inspiring ordeals seems most likely to make that situation worse, not better, particularly when their whole futures are at stake, and the ordeals are not very good measurements of what they're supposed to evaluate.

One of the most visible changes so far is a significant number of students who have satisfied all the requirements for graduation *except* passing the requisite Regents exams, and are then denied a diploma and/or admission to college solely on the basis of that one test score. Most of these "casualties," as administrators call them with seeming indifference, are recent immigrants who have not yet become fully comfortable with English. As I have often remarked, I'm a firm believer that immigrants to any country need to learn the prevailing local language; but I also think that some allowance must be made for the fact that that takes time and may lag behind the development of other skills. I certainly don't think such a lag justifies forcing a person's entire academic career to a grinding halt.

And immigrants aren't the only people who can succumb to this danger. Some people may be very good at actually using a subject in the way it would be used professionally or in other aspects of "real life," but simply not be very good test-takers. Yes, it would be highly desirable to have a good way of measuring scholastic achievement, uniform enough to permit meaningful comparison among students coming out of different schools. This could help motivate both students and teachers to make sure they really do what they need to. If *either* of them fails to, the students ultimately suffer—and students (as some educators unfortunately need to be reminded sometimes) are what education is all about. Left entirely to their own devices, with no basis for comparison with what's happening elsewhere, some teachers may slide into a habit of accepting shoddy work as "good enough"—and some students may not know any better than to believe them.

Preventing that is the alleged purpose of requiring standardized tests such as the Regents, SATs, and others of that

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sort—but such tests are *not* a very good way of doing what they're supposed to do. Their basic weakness is that while command of the subject matter is generally *necessary* to do well on them, it is by no means *sufficient*. Such tests require *two* sets of skills: those allegedly being tested, and a completely separate set of skills in taking tests *per se*. Those who do well on the tests are those who have both sets. Those who know the subject cold but tend to panic on tests may find it very difficult to look as good as they are under this particular kind of examination. Those who stay cool as a cucumber and have learned some test-taking tricks may look better than they are.

And *anybody* can have a bad day occasionally. A wise professor of mine understood this and announced up front that she would give three one-hour exams during the semester and drop the lowest grade—but not the final. (The last provision was to discourage students who aced the three one-hour exams from sleeping through the last quarter of the semester.) The policy made so much sense that I adopted it in most of my own teaching—but (don't tell anybody!) I once made an exception to the "never-drop-the-final" part of it. I had a very diligent student who through an entire year had done middle-"B" work as solidly consistent as any I'd ever seen—and completely blew the final.

As soon as I graded it, I sent my spies forth to track her down and tell her to come and see me right away. When she got there, my first words were, "You panicked, didn't you?" She nodded, and I explained that I knew the symptoms because I'd done the same a time or two myself. "Don't tell anybody I'm doing this," I went on, "because nobody should assume the final doesn't matter. But I know you and I know what you've done all year, so I'm dropping *your* final because I know it's a meaningless measurement—a flawed experiment. And I wanted you to know before you had to take any more finals."

Such meaningless measurements are most likely to occur when they can do the most damage—precisely *because* they can do the most damage. Many people, quite understandably, get very nervous, to the point of having their normal abilities impaired, when they know that a disproportionate amount is riding on the outcome of a single test. (Another example from my own experience: When I took the flight test for my pilot's license, it was quite obvious to

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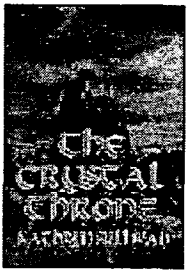

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me that I was doing some of the poorest flying I'd done in many hours—but the examiner, who had also been my instructor during some of those hours, gave me my ticket anyway. When I had it safely in hand, I asked him, "Does *everybody* do worse on the test than during their prep time?" and he answered, with no hesitation at all, "Yep.")

So those are my biggest objections to the widespread emphasis placed on the Regents exams and other tests like them. They're not reliable tests, and there's way too much riding on them—which, in practice, makes them even worse. These facts bothered me about them way back when I was a student myself—especially when I was subjected to the doctoral qualifying examination in a *science* department. It struck me as a colossally ironic thing for a bunch of scientists to make a colleague's future completely dependent on the outcome of a single extremely high-pressure test. Any competent scientist knows (I thought) that to measure the properties of a system you need an experiment that (1) disturbs the system as little as possible, and (2) takes enough measurements to be sure they're statistically meaningful. A doctoral qualifier, or a Regents exam, or any of the others of their ilk, is in essence a seriously flawed experiment: a single measurement on the system in a highly disturbed state—and that result is taken more seriously than all the observations collected on the same system under more normal circumstances over a period of years!

But I have one more objection, no less serious, which grows out of those two. Because of the intense pressure to perform in this one highly artificial way, many teachers feel obligated to slant way too much of their teaching at the very specific, artificial goal of doing well on The Test—which may or may not say much about how well the students will do at using the subject matter in its actual applications. The time spent on preparation for The Test is time that cannot be spent on activities that might

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have far more actual educational value, such as research projects. I have heard many teachers complain bitterly about this; yet they feel compelled to spend more and more time on test preparations, because the good ones want to make sure their students don't get trapped, and even poorer ones know their boss—the principal or headmaster—is determined to keep his numbers up, and heads will roll if that doesn't happen.

I'm not saying it will be easy to find a better way to do what things like the Regents are supposed to do, but I am definitely and emphatically saying that we need to. As what might be a small pointer in a better direction, I will simply state one observation that seems to me almost too obvious to require statement: If your students are not doing well enough on the tests they're already taking, what they need is not harder tests. It's better teaching, to make sure they can pass the tests they're already taking.

And *then* it will make sense to start working on harder tests—and teaching to help students pass them.■

I think anything . . . that is contemplative, silent, shows a person alone—people always feel it is sad. Is it because we've lost the art of being alone?

—Andrew Wyeth

I have always imagined that paradise will be a kind of library.

—Jorge Luís Borges

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In Spirit

Pat Forde

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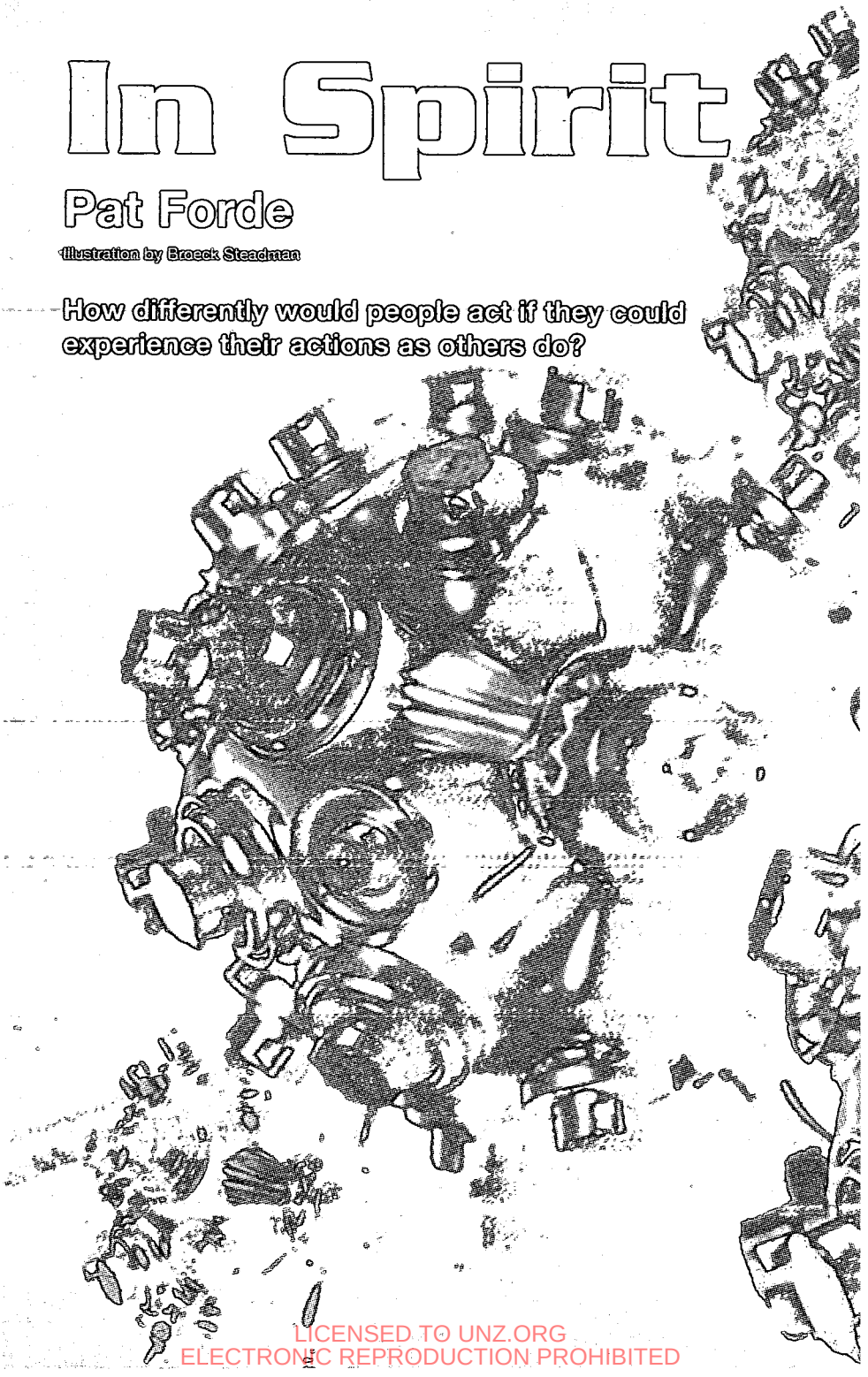
How differently would people act if they could experience their actions as others do?



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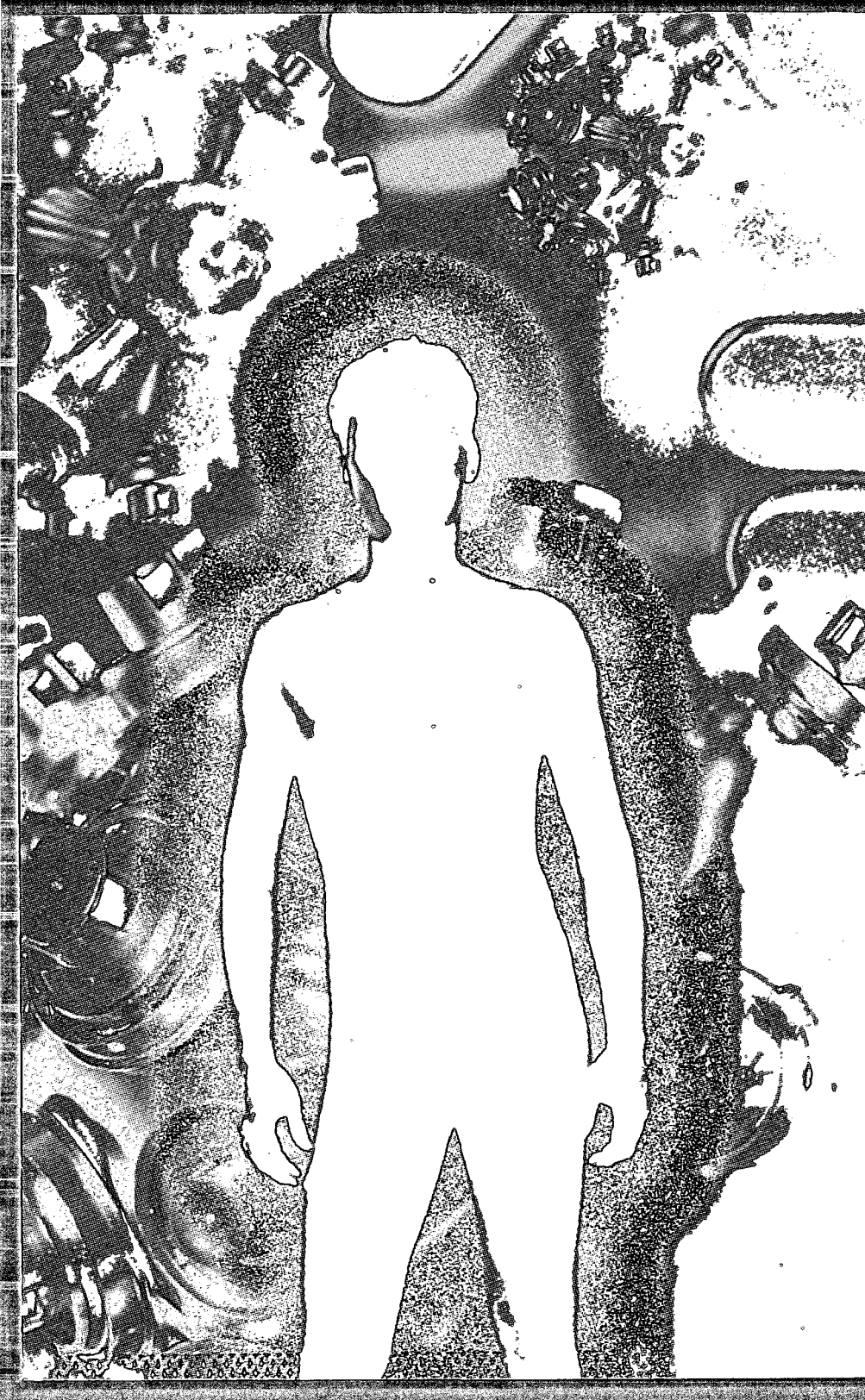

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The story I want to tell you now is the oldest story in the book. It's the defining story of humanity, and it goes like this: A new tool comes along. Men see it in the world or in their minds. They strive to reach it, attain it, hold it aloft for a moment's wonder. Then they wield it wisely or wantonly, and in so doing they transform a society—a tribe, village, city, corporation, nation-state, or global institution, spreading the effects on up the evolutionary ladder of civilization.

It's a familiar story, yes. But to date, no tool has transformed human society as drastically as deep-projection technology. Not the first spark flinted for a fire, not the first ink put to page, not the first night lit by electricity, not the first atom split inside a bomb. None of those shocks were as transformative as Trans-dimensional Extended Projection technology, a.k.a. deep-projection.

How can I be sure of this?

I'm sure because deep-projection allows the impacts of those famous shocks of the past to be *directly re-experienced*—by allowing the past to be *directly revisited* from the present by qualified volunteers, a group that included myself from the very start. Yes, I was there, at the Institute for Advanced Study in New Jersey back in 2030, when the pilot test was performed. I was there, and I witnessed an opening being made for the very first time into unseen dimensions that stitch together the universal fabric of reality. I watched the very first volunteer, a dear friend of mine, project across the unseen frames of reference that surround and suffuse our reality; with my own eyes I saw her enter a dimensional plane that shared *its* reality with a precisely targeted moment in the past. You may or may not know that she was killed the following year, in riots at the Institute.

Whatever you may think of her, and whatever you may have heard of our early efforts, do not be misinformed about our technology. Deep-projection was not "time travel" as anyone had foreseen it. It was more like stepping into a virtual-reality display of the past, a past that we cannot affect in any way. . . . At least, we believed that at the start. And for the most part it's perfectly true: we cannot affect the past in any way that can change what's already happened.

It's also perfectly true that some of my fellow volunteers made the mistake of targeting moments in history that proved explosive to cultures founded upon those misunderstood moments. Still more explosive were news stories about the projection volunteers who returned from the past suffering strange side effects, consumed by poisonous thoughts and emotions long put to rest, feelings they rereleased into our present-day world.

Those news stories were true too, though I myself never experienced anything so negative during projection. In fact, my own experience was so much the opposite I felt compelled to join what's being called New Spiritualism, a movement among deep-projection users that focuses on "weak interactions" with the past. Before long, I was an outspoken leader of this movement.

And that is why I was called on to testify at international hearings on the global crisis that deep-projection technology had triggered, hearings convened at the Hague in the fall of 2033. By that time, a worldwide ban on the use of the technology had been decreed, and most deep-projection centers were already shut down. Many had been ransacked by mobs, and in some countries, projection facilities had been burned to the ground, the staff and volunteers that made it out of the fires alive arrested or worse. . . . I was one of the lucky ones. Lucky enough to avoid being lynched, and lucky enough to be asked to present the first case-study on our technology at the international hearings.

Even the World Court was curious to hear about my one-of-a-kind case study—rumors had been circulating for

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months about an unusual group of Americans who'd approached me, seeking assistance for the innovative application of deep-projection they'd come up with. The court saw my story as a potential antidote to all the media horror stories concerning what scientists had seen or experienced in the remote past.

When I walked to the podium in that great court, I began by stating emphatically that deep-projection was not a dangerous technology in and of itself. It was not, after all, a weapon. It was merely a kind of transportation device. So whether it was used for good or for ill depended on us.

Then I shared with the members of the World Court what I'm about to share with you: the case of a voluntary projection made by an inmate of Lewisburg Federal Penitentiary in Pennsylvania.

What follows is adapted from the inmate's deposition. . . .

Raed was in his thirtieth year of incarceration at Lewisburg when they made him the offer to participate.

It happened on the day of his annual psych review, and the instant he entered the review room Raed knew something big was up. The faces on the penitentiary's psych panel changed slowly over the decades. A few more wrinkles, an occasional fresh new face to replace a retiree; but few new emotions. Yet *three* new faces were visible on the panel. And Lew's balding senior psychologist looked guarded, even confused.

Plus there were a couple of lawyers present in the room, which was very odd indeed. Raed hadn't even *seen* a lawyer since 2014. . . .

"Please sit down."

A guard ushered Raed to the lone chair facing the table of psychologists. He lowered himself onto the chair, feeling small, even though he was taller than anyone on the five-man panel; he could see right over their heads to the mirrored observation-pane in the wall behind them. Raed was careful not to look directly into the mirrored pane, not because he was afraid of being watched—after thirty years at Lew, he'd feel out of sorts if he *wasn't* watched—but because he didn't want to see how much he'd aged in Lew. There were no mirrors back in his cell, of course.

"Something different on the agenda today, Raed," Lew's senior psychologist said, managing to sound both weary and impatient. "I'd like to start by informing you of an assessment made by our medical staff." The old man held up a slate plugged into the table, read from it: "Raed, you were twenty-four years old when given over to the supervision of this penitentiary. With the supplements we feed you and with the fitness routine you've elected to maintain, the prognosis is you'll have another fifty years with us here at Lew."

That simple assessment slammed into Raed. He blinked at the senior psychologist, feeling disoriented, drawn out of the "safe-houses" the man claimed Raed had in his head. *Fifty* more years!

He hardly heard what the two sharply dressed lawyers were trying to tell him.

". . . which is why we're your court-appointed representation. We're here to tell you about a petition made by a group of interested citizens."

What were these men going on about?

"Concerning an experimental rehab program," one of them continued, "that might be looked upon favorably by the Federal Board later, if you agree to undergo it."

Raed suddenly laughed, something he did so rarely it hurt his throat a little. "To what end?" he asked them. "Reducing *one* of my life-sentences?"

Raed was serving two thousand back-to-back life-terms. Convicted of being an accomplice to "one of the most heinous crimes in recorded history," he'd received the longest prison sentence ever handed out by a United States court—partially because he'd been a naturalized American citizen, but mostly because

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he'd been fully aware of the outcome of the crime. So Raed was *never* going to be released, reintroduced to society.

Extending him an offer of rehab was a ridiculous gesture.

"See this program through, and who can say what's possible?" The lawyer shrugged. "For now, two things are directly on the table. One: an opportunity to see your daughter."

Again Raed blinked at them, feeling his face reddening, stunned into apoplectic silence. When he'd entered Lew, he'd left a wife and a three-year-old daughter behind. And the last time lawyers had come to see him was back in Raed's thirteenth year here, when he'd been served divorce papers from Haifa *and* papers disowning him as a parent from Basma, his daughter. Basma would have just been old enough to sign those papers, that year. Had she changed her mind, now that she was in her thirties?

"Also," the lawyer went on, "an opportunity to enter the world beyond your prison, in a limited and—well, unusual way." The lawyer said this as though he didn't quite believe it.

Certainly Raed couldn't quite believe it. He hadn't seen the outside since his trial ended. The thought unnerved him, for he had no idea what the world was like anymore. "Who made the offer?" Raed managed to ask.

Now the second lawyer spoke up. "A group of citizens who have a certain relationship with you, but do not wish to be identified."

"Ah." Raed knew just what group the lawyer was referring to. He sighed, "I need to think about it."

After the review was over and the guards took him back to his home in Lew Cell #1, Raed found he couldn't *stop* thinking about the astonishing offer made to him. Raed knew the group that had petitioned for the offer pretty well: an Arab-American Rights group that checked in on him over the years, to ensure he wasn't abused in the penitentiary simply because of the notoriety of his conviction. In the occasional letter he'd received from the group every couple of years, they emphasized Raed *must* not advertise their low-level connection with him. They threatened to stop making inquiries on his behalf to the Lew administration if he failed to maintain their privacy.

Raed understood the group wasn't actually "making inquiries on his behalf" because they were concerned about *him*, per se. Their concern—especially during the early years—was that Raed might take his own life in prison and become a martyr to his old cause.

Raed had no pent-up desire to become a martyr, and he was not considered a serious candidate for suicide—although, due to his uniquely lengthy sentence, he was permanently assigned to the suicide-watch list at Lew. If ever there was a prisoner who had nothing to looking forward to, it was surely Raed.

But now he could be a research volunteer for a new one-of-a-kind rehab program.

He would get to see his daughter, they'd told him.

He would get to walk the outside world for short stretches.

And for long stretches he would get to leave Cell #1, the largest and most expensive cell in the penitentiary, where Raed resided alone under constant guard and camera surveillance.

After thirty years, the cell was a home to him. Raed had taped up a picture of soaring desert dunes on one wall, a vista of the Moon over the ocean on another. He'd nursed a dozen plants up round the tiny window overlooking the courtyard that Raed could see out of, but no one could see in through. He'd even built up a modest bookshelf, though none of the books dated from this century. And there were no newspapers allowed in here, there was no television. Raed's media exposure was censored from the start of his incarceration "in or-

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der to prevent continued political inflammation of the prisoner."

Nevertheless, in the early years Raed protested this political censorship of news by cutting himself off from *all* news, *all* knowledge of outside events. He'd withdrawn from modern civilization completely the day he set foot in Cell #1. And why not? Raed had lost *everything*. So he restricted himself to reading older texts, like the *Alif Layla Wa Layla*, the Thousand and One Nights. Shaherazade, it turned out, provided a soothing escape for a man sentenced to spend ten thousand and one nights in a single room. At his own insistence, none of the books on Raed's shelf were published after the day of infamy he'd been convicted of participating in: the day the Lew staff still referred to as "9/11."

In the early years, Raed's psychologists hadn't been bothered by his self-censorship. But after the first decade, they changed their minds, complaining that he was retreating too far from reality. That's when the psychologists began to talk about "safe-rooms" in his mind, about a "labyrinth of rooms" he was building to escape not just from imprisonment but from himself. Raed snorted when he first heard this metaphor—but even then he'd suspected the description was all too apt.

An internal labyrinth. A long chain of rooms within rooms to hide in at the back of his mind.

For years he'd been building them, extending himself into new selves, splinter-selves that left his memories of life on the outside stored in some distant mental "room." In the decades since Raed arrived at Lew, the administration had constructed four new versions of Cell #1 just for him, each room a little more livable, more "humane" than the last. Over the same period, Raed probably constructed forty new rooms inside his head, just to block away the portions of his mind he didn't need anymore. The first to go was his entire twenty-four-year-old "outside-self," long lost now, dropped down some dusty crevice of the labyrinth Raed built to divide and conquer himself. During the ensuing years he'd wound his way deeper into the labyrinth, until he'd found a room strong enough to withstand eternal confinement and isolation.

After three very long and sleepless nights spent reflecting on his position—something Raed hardly *ever* did—he broke down and asked what was involved in the experimental program. He was told it involved a new technology, but much of the program itself would be left up to him.

A month later, Raed was taken out of Lewisburg Federal Penitentiary for the first time since he'd been brought into it. He was taken out just after dusk in an armored van without windows, and driven through the mountains toward a destination unknown.

By the sound of it, the armored van had a police escort, and the escort led the way for about an hour, about as far as Reading, Pennsylvania might be, Raed guessed. Then the van stopped, and he heard the driver talking with security guards. Raed heard something else too, a muffled sound familiar from his trial: the sound of protestors shouting at the van. He was astonished to think the public had found out he was being brought here, had gotten up in the middle of the night to come here themselves—but Raed wasn't surprised that people still harbored so much hate for him. On the rare occasions he gave interviews, Raed saw the wariness in the journalists' eyes, caught them looking at him like a kind of living ghoul out of the pages of history.

The van parked in a loading dock. Raed was unloaded under guard, then brought to an empty conference room, wearing a monitoring restraint-collar that would sedate him instantly if he tried anything. Moments later, the same trio of young psychologists who'd sat

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through his review in Lewisburg entered the room, followed by a pair of middle-aged men introduced to him as "senior researchers." The two researchers began outlining their experimental program, describing the new technology Raed would be required to use....

Raed listened to them, briefly astounded, then disappointed. "Projection" through a "dimensional fold" to a "targeted moment in the past"? Raed's mind began doing backflips trying to guess what was *really* going on here. Had the legal climate in the United States changed? Had new forces declared Raed should be put through some punishment alternative to confinement?

He told the researchers flat out he did not believe them. Traveling to the past was impossible, he didn't care how many decades had gone by since he'd been in the outside world.

So they took him down to the main "projection" floor, brought him into a room dominated by a big spherical cagework. There had to be a hundred different bars to the cage, not all of them completely encircling it. And hanging in the cage's center was a body harness. Raed examined it suspiciously, wondering what exactly these men were trying to trick him into.... All the cage's arcing yellow bars were studded with cones that pointed inward, toward the harness suspended by a dozen blue coil-cables.

"Questions, Raed?" one of the psychologists asked him.

"What are the curtains for?"

The long back wall of the "projection" room was concealed—to hide a viewing gallery?

But then one of the guards who'd accompanied Raed from Lew drew back the curtains, revealing a long pane of Plexiglas that separated the room with the cage from—

A much larger room with a hundred identical cages that were *occupied by suspended people*.

At least, the suspended occupants *appeared* to be people. Raed stepped up to the Plexiglas pane, pressed his face against it, uncertain whether he was seeing an image televised across the pane or a real room on the other side of the pane.

The arena-sized room was real.

The hundred-odd yellow cages seemed real.

But all the suspended people looked blurry, far-off, fake, like projected images. Most of the image-people were moving, some running in their cages, a few leaping and rolling in midair.

"Those people aren't real," Raed said over his shoulder, unable to turn from the pane. He was mesmerized.... Abruptly, one of the closer cages flashed with light, and the false floating image-person inside was instantly transformed into a clear-as-can-be jumpsuit-wearing woman, a real-as-can-be woman who stepped out of the yellow cage, a little shaky on her feet, but otherwise not visibly worse for the experience. She began conferring with a three-man team clustered round display-desks adjacent to her big yellow cage.

"You're telling me that woman was deep-projecting into the past?" Raed asked, noticing now there was a separate team for each harnessed and hanging "time traveler." If this was all a hoax, it was an elaborate one.

"Volunteers like her call it 'ghosting'," someone behind him said. "You'll see why if you decide to follow our program, and volunteer to try it for yourself."

The "volunteers" in the cages beyond the Plexiglas pane were *not* other prisoners, according to the researchers. The volunteers were mostly historians and cultural anthropologists, a handful of students, and others who routinely "ghosted back to the past" from this facility round-the-clock. Raed's researcher-guides claimed the yellow projection cages allowed people to experience the *physical reality* of the past without fully being part of it.

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But Raed knew that it was all a trick of some kind. If those volunteers were experiencing any sort of "projection," it was the sort of computer-fabricated reality the outside world used to call—what was the word? Oh yes: a *simulation*.

That was the only thing "projection" could be, the only thing Raed could bring himself to believe. . . .

His rehab programmers seemed prepared for Raed's disbelief.

For the rest of the night, they cloistered Raed and his two Lew guards in the otherwise-empty conference room, so that Raed could browse through "holeos"—interactive 3-D training videos. The holeos began with a list of weird implications of "classical quantum theory": how subatomic particles appeared out of nowhere and then disappeared, how such particles could exist in many places at once, the development of a mathematics that suggested particles were boring between dimensions.

Apparently Raed's rehab programmers knew he'd been exposed to such strange concepts before, while studying for his certificate in electronics.

Of course they knew. Raed's electronics training came out at the trial because his certificate got him a position with the airline, a low-level job that allowed him to scrutinize airport security. . . . Anyway, one of Raed's electronics courses ***had*** touched on quantum theory—mainly for the students continuing on into cell-phone or computer technology. Raed ***hadn't*** understood the half-day "quantum overview" his college course included.

According to the holeos, Raed wasn't the only one who hadn't understood. Most physicists chose to treat the theory simply as a convenient way to calculate and predict the positions of particles, rather than believe the world could *really* be riddled by multiple dimensions. The holeo invited Raed to imagine Copernicus and Galileo choosing to ignore the overall implication of their new way of calculating and predicting the positions of the planets—and refusing to believe the Sun could *really* be the center of the solar system.

Raed didn't see why it was important for him to know or imagine any of this. But he didn't want anyone to think he was backing out of the program. He didn't want to be driven back to Lew, not just yet. And he was an expert at biding his time. Patience and playing the game were the essential survival skills of a long-term prisoner.

So Raed patiently sat through a tedious holeo-guided history of quantum-in-the-large, which elevated the theory from the subatomic realm up to far larger scales. He listened patiently to young scientists attacking the notion that "multiple dimensions collapsed into a single dimension" whenever a human observer happened along—how could a theory of matter seriously include human consciousness in a central role? He patiently examined 3-D renderings of the first machines built to scan "N-space," a theoretical realm that surrounded and suffused the visible Universe with all manner of strange dimensions.

But when the holeos moved on to the topic of "forces experienced during projection into N-space," Raed must have groaned aloud, because his researcher-hosts came in and turned off the holeos. They didn't seem disappointed; perhaps they'd thought he'd give up on their theoretical material much sooner.

Next they let Raed watch an old pre-millennium black-and-white movie that was supposed to give him an idea of what it would be like to be "projected" to a city he could do little but wander through.

The setting was Berlin, and the city was revealed through the eyes of two angels wandering among the living—angels who resembled two somber German men in stylish dark greatcoats. The citizens of Berlin couldn't see them, but

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the two forlorn-looking angels could see and hear people talking in the world around them. They could even hear the thoughts of people, although in those parts of the film the soundtrack reverted to German, so *he* didn't get to hear what the citizens were thinking. All he could tell from the tone of their untranslated thoughts was whether they were sad or happy, angry or afraid. . . .

After it was over, one researcher sat down with him, described the projection experience as a lot like being a ghost lurking in an otherwise real world. Projection volunteers could see the physical environment of the past perfectly, but could not be seen by people in that past.

"Because," the researcher laboriously explained, "light is so low in mass that it merely has one-way transdimensionality. Volunteers can see light from the past, but past-states can never receive light from farther along Time's dimension."

Raed nodded dutifully, wondering what all the researchers here were *really* up to, and why they would try so hard to make him believe in an impossibility. . . .

An hour before dawn, he was hustled back to the armored van waiting in the loading dock, handed printed materials to review if he wanted to, then whisked out through the unseen but audible protestors and returned to Lew to spend the day resting in his cell. Which was fine by him. Stepping back through the door of Cell #1 felt like waking from a dream. He didn't feel so out of sorts here, so confused and vulnerable.

But he couldn't sleep. The thought that he'd just been beyond the penitentiary's walls had opened up a crack inside his thinking. He still didn't know what to make of his night out. So much scientific argument just to convince him of something untrue?

Eventually he gave up on sleep altogether, and began looking over the strange explanations in the support material they'd given him, looking for loopholes, looking for the truth behind their lies. Raed used to be an imaginative man. But imagination was not a good thing to have in prison and he felt very rusty. Long-forgotten thoughts stirred up faded memories of his teenage struggle to master challenging Western concepts—an education paid for by the organization, the money funneled to Raed through his cousins Nazir and Sayf, both of whom died back on 9/11.

The truth about "deep-projection" finally dawned on Raed. Now he saw through the rehab programmers' game, and saw how to get what *he* wanted: a chance to see his daughter Basma, whom Raed hadn't seen since she was three years old.

With that reward firmly in mind, Raed finally fell asleep.

The next night, he was again driven out of the Appalachians to the deep-projection complex. And again he heard protesters out in force as the van went through the complex's gates, although the van's walls muffled whatever was being shouted at him. . . .

Waiting for him in the same conference room as before were the three psychologists and the two so-called senior researchers—his "projection parole board," for all intents and purposes. These five men could approve his participation in the program or send him packing for the rest of his life.

"Questions, Raed?"

He held up the printed materials he'd brought back with him. "Is it really necessary for me to know any of this before I can project?" Raed already knew the answer, but was curious to see how they'd try to rationalize it to him.

A compact researcher with close-cropped gray bristles instead of hair took the printouts back from Raed. "You reviewed all this?"

"Yes."

"Well then, let's see where last night's holeo-lessons broke off. . . ." He flipped to the final pages. "Ah, yes: N-space

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forces and the role mass plays in them. Complex stuff—but crucial to understanding what you'll encounter during projection, how you can move around, and so on."

An evasive answer that simply pressed ahead with the logic crafted to convince him. Indeed, that was the ultimate purpose of all this preparatory theory:

To make Raed believe "projection" would show him the real *past, so that the psychological benefits of the rehab program could take effect.*

The science was all part of the rehab, part of the game these psychologists were playing with him. He recognized their bag of tricks well enough.

But Raed could play the game better than anyone. After all, he'd lived in America for seven years and played the game of being one of the ordinary people on his Brooklyn street without anyone suspecting his deep-seated separateness. So he would play along with tonight's game, stay on the move inside his head, hop from room to room through the labyrinth until he came out as the winner. . . .

This time, the compact senior researcher with the bristle-hair remained behind when the others left. The man introduced himself as Francis Drummond, a volunteer himself during the earliest test-projections. He seemed committed to helping Raed understand the hard stuff.

"Get through an hour with me, and you'll get to project for the rest of the night," Francis promised as he began summoning images onto the conference table's display-surface: the Moon; a mountain; a building; a metal barricade. According to Francis, each of the displayed objects was massive enough to exert force "into many N-space dimensions." But people who projected through N-space into the past could apparently thrust their ghostly hands right through a foam mattress—or even through a pane of glass, if they were patient enough.

Raed nodded, knowing all this information was being trotted out to explain away the defects of the simulation he'd be projecting into. "Will I be able to walk through walls, like the two German angels in that black-and-white movie?" he asked, getting into the spirit of the game.

"If it's the wall of a tent, sure. There's a kind of 'tingly give' when you step through thin structures. But you can't step through ordinary walls of concrete or steel, no. It all comes back to mass and massive structure. . . ."

Over the course of two hours with Francis, Raed struggled to keep on top of the complex concepts paraded before him. Francis even told him about the big surprise from the earliest test-projections: "We discovered that life-forms of sufficient mass exert some kind of energy into a few dimensions; we call these 'biomass signatures.' Volunteers pick up these signatures when animals of a certain size wander close to them."

How did they simulate *that*, Raed wondered. "That include people?"

Francis nodded. "Conscious animals exert the strongest signatures. Please don't interpret this as something 'psychic'; individual thoughts are far too fleeting to be sensed. They essentially have no weight. But strong emotions can last a long time in the forebrain, fill the hindbrain, contort the face, change the way we walk, permeate our muscle-tissues. Massive, you might say."

Francis seemed to be trying to reawaken Raed's mind as much as teach him about projection. And that was all right with Raed. Because if he was going to go through their rehab program, and notice all the things they'd want him to notice, and win the reward they'd promised him, he'd need to be on the ball. . . .

"Well, that about covers it," Francis finally announced, shutting off the conference table. "Any last questions?"

Raed sensed this was a test he must pass. "You said gravity has 'two-way

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transdimensionality'?"

"Yes." Francis seemed pleased. "It's a strong-weak interaction. Gravity from the past is exerted strongly onto the N-space fold you'll be in, and your own mass exerts itself weakly onto the past—"

"Doesn't adding my mass to the past *change* the past? I thought paradoxes were outlawed by quantum-in-the-large." Raed's rusty brain was beginning to work again. He wanted to show this clever man he'd been listening and he would catch flaws in his logic, if Francis wasn't careful.

"Paradoxes *are* ruled out. Our technology wouldn't work at all if it were possible to project into the future, for instance. And according to quantum-in-the-large, people who project through N-Space to the past already visited that past the first time around, so to speak. So their mass was accounted for, and their presence won't change anything. They can only go back and weakly interact because they were there all along."

"I understand you perfectly."

"Excellent." Francis stood up. "I'll send in a medic who'll take you downstairs, get you hooked up to the cage."

The man strode out of the room.

And Raed waited, feeling out of his element, out of his cell, completely out of sorts. He glanced at the guards watching him from their shadowy corner of the room. He glanced at a bookshelf against the conference room wall, took down a text, looked at the cover: *Creating Transient N-space Intersections with Past Time.*

A book about a false bunch of theories? The book's spine was cracked worse than Raed's copy of Shaherazade, as though it had been thumbed through many times.

The crack deep inside his thinking hadn't gone away; it was still down there, wedged wider by all the information they'd fed him. And now a hint of fear was seeping up through that crack. . . . Because Raed knew what his rehab programmers were up to, he could guess their "precisely targeted-destination," oh yes.

They intended to project him back to 9/11.

A burly male medic arrived, and led Raed and his two guards down to the same curtained chamber off the main projection arena, where the guards removed his restraint-collar. The medic explained that the chamber's projection cage was the only one isolated in the facility, set up just for Raed. Then he helped Raed don the harness, which was worn under his clothes, against his body so the 'trodes could record biofeedback. After strapping it on, Raed got into a magnetic jumpsuit. The medic told him he could put his clothes on over the top of the jumpsuit.

So he did, fingers trembling as he rebuttoned his shirt. . . .

The pair of lawyers who'd first appeared at his review back in Lew suddenly reappeared with a slate for him to sign. They informed Raed about the protests being held outside the facility. The protests were *not* about him, they said; no one outside knew he was in here.

"What are they protesting?"

Apparently the people outside felt projection technology was too dangerous to be used. The lawyers assured Raed no volunteer who'd undergone projection had been *physically* harmed by the process itself; it was *emotional* damage, that was the real risk. The potent "biomass signatures" people gave off in the past could be quite corrosive.

"That's the only danger?"

One of the lawyers told him, "There's a movement called 'New Spiritualism' that contends the transdimensional interaction can be positive. Some New Spiritualists are sponsoring your rehab program, by the way. . . ."

But Raed was hardly listening, seeing more of the truth peeking out from behind their lies. The protestors outside

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were opposed to the *simulations* this technology produced. And now Raed had been brought here—because if they could convince *him* the simulations were real and use them to help him rehabilitate, wouldn't that be a big coup for a beleaguered technology?

Raed signed the slate held out to him. Then the lawyers asked the medic to strap a special "ripcord" over Raed's clothing, reiterated that he could back out at any time, and as they left the chamber, his personal projection team came in. An Asian senior researcher, a boyish-looking controls operator, and finally a woman psychologist—a Muslim psychologist, no less, wearing a black cotton burqa that kept her hidden and proper. Didn't they realize Raed was no longer a devout?

As Raed was introduced by his guards, the woman's wide-set black eyes looked coldly over the burqa-veil at him. No doubt she'd been sent by the Arab-American Rights group who'd petitioned to get him into this crazy rehab program.

The team quickly took their positions, the medic helping Raed through the yellow bars into the cage, then pulling down the blue coil-cables and magnetically latching them to anchor spots on the jumpsuit beneath Raed's clothes. The moment the medic stepped out of the cage, the operators powered up the blue cables, which recoiled, hoisting Raed comfortably into midair. He tried to calm his breathing, and listened to the chatter around him.

"Got five hours."

"Time for, say, ten projections?".

"Aim for ten, minimum."

"Curtains open or closed?"

Raed realized this was addressed to him. "Open." He didn't care if anyone looked in; he wanted to look out. So the curtains were drawn aside, and Raed peered at the hundred-odd cages across the main floor, which were again all occupied by volunteers, some in jumpsuits, some in tracksuits, some in regular clothes. Presumably this facility was packed day and night. He heard something below him, and realized the Muslim psychologist had stepped into the cage.

"Your program for tonight involves a number of projections, all of them focused on a primary time-locus—"

"I know where you're sending me," he told her. "Back to the day I was convicted of being a party to. As punishment," he added.

The psychologist shook her veiled head. "It's up to you what you get out of the projection experience. If you want the offer made to you upheld, you'll have to stick the program out. On the other hand, if you decide you no longer want to continue—" She indicated the ripcord round his waist. "Pull this, you'll instantly shut down the cage-frame and return to the present."

Raed had been advised by the lawyers that any ripcord shutdowns would be treated as a withdrawal from the program. "I'm not afraid," he said to her.

He was curious, though. Raed hadn't thought much about 9/11 in nearly two decades. All by itself the mind sprouted rooms within rooms to tuck away what was destructive. And tucked a hundred rooms away from the Raed of today was the twenty-four-year-old Raed who'd aided and abetted his cousins Nazir and Sayf. He no longer had any connection to that Raed, but he *was* curious to know how history now looked on the events of that day. . . . The medic was now strapping a lightweight breather-mask round Raed's neck. Would it secrete some kind of hallucinatory gas?

"In case we project you to the wrong coordinates," the woman psychologist explained, still standing below him. "You'd pass out in certain environments, but there's little chance of real physical harm. Anyway, you can use the microphone on the breather to call out to us during projection. We'll hear you. The people of the past *won't* hear you, remember. Sound can only travel one way across the dimensional fold, just like

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light. Now brace yourself," she warned him. "The world of the past's going to feel both startlingly real and surreal."

With a twirl of black cotton, she quickly slipped out of the cage. And within seconds the inward-angled cones on all the arcing yellow bars began to focus shimmering beams on him, opening a "transient N-space fold" around him. Raed blinked through the bars, met the hard eyes of the young Muslim psychologist, still refusing to believe—until the woman began to blur, and shift, and slide off to one side, and everything around Raed swirled into a tunnel of light—

A light *thump*, and the tunnel of light focused into a tubular space. Raed's eyes adjusted, recognized an oh-so-familiar interior: he was inside a large, mostly empty 767 passenger jet sitting on a runway.

Raed had dropped down into one of the rearmost seats from midair, as the "gravity" of the simulation took hold of him. It *was* a simulation, wasn't it? He blinked at his surroundings, seeing every detail of the seat-back ahead of him and the belts and buckles lying on the empty seats beside him, the empty row across the aisle, the magazines and folded-up meal tables all *perfectly* visible, his surroundings *absolutely* real no matter which way he looked. *Light has a strong multidimensionality*, Francis had said, *but such negligible mass it can only cross one-way, from the past to the present.* . . .

But then Raed noticed he was sinking *right through* the padded seat-cushion beneath him—he could feel himself bumping down against the hard steel frame *inside* the seat itself. Flaws in the simulation, just as he'd suspected! He let out a sigh of relief, and watched his body rebound slightly, settling into place almost on the surface of the seat cushion visible between his legs. It was a strange sensation, but Raed was sure it was controlled by the coiled harness cables back in the "projection" cage he had to be still hanging in. . . . From a great distance away, too far off and far too soft to be real, the whining sound of jet engines powering up. More like a whisper, when the sound should have been screamingly loud in his ears—another flaw! Raed felt he was hearing a faulty soundtrack in a movie theater too big for the speakers.

But then he recalled the materials he'd been given to study: sounds would be strange, nothing would be loud enough to make out unless Raed was standing close to the source.

Slowly the 767 went through a 30-degree turn on the runway, and the quality of light spilling through windows across the aisle made it clear to Raed this was an early morning flight. His heart began to beat faster. He leaned over the seat beside him, peered out the oval window. His plane appeared to be taxiing toward a main runway, and the airport was—

Logan International, Boston.

No doubt this was supposed to be the fateful day. Raed struggled to get up, wanting to see if he could see Nazir or Sayf seated in the rows ahead, biding their time until the 767 had taken off. But no, something was wrong—the weird far-off whining of the engines was powering down, shutting off altogether. Raed tried to get to his feet, struggling with the distorted friction of this simulation-world, all the while clinging to the fact that he was really attached to a harness in the air somewhere. In the seat ahead of him, a passenger was sleeping, one arm thrown across his lap, digital wristwatch visible: 9:13 AM.

An hour *after* the time they should have been in the air, if this was one of those infamous flights. No wonder the plane was at a standstill! Plopping back down in the empty window seat, Raed pressed his face to the strangely rubbery glass of the window, caught sight of other motionless planes lined up on another runway. . . . On the morning of 9/11, all flights in the country had been

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grounded shortly after 9 AM.

They'd projected him back aboard *the wrong plane!* Raed released a breath he hadn't realized he'd been holding.

But if it was all just a simulation, under the control of the two projection operators, then shouldn't this *be* one of the planes that had left Boston an hour earlier?

He moved back to the aisle seat, saw a stewardess walking towards him from the front of the plane, looking distraught, touching the passengers she passed on the shoulder, and speaking soundlessly to them. Raed heard nothing at all until she was quite close, then he heard the stewardess speaking four words to the passengers in the rows ahead of him: "Never forget this day."

Her voice sounded too loud, and more than a little hoarse, as though she was on the edge of tears. "Never forget this day," she boomed again, leaning in to touch the passenger in the seat directly ahead on the shoulder. She passed Raed by without looking at him, but her knee brushed his hand, resting on the hard plastic aisle-arm—

FEAR-ANGUISH-DISBELIEF! All three emotions flooded out of the passing stewardess and into Raed, the potency of his brief physical contact with her a kind of pain he'd never experienced before. He recoiled from the aisle, clutching his hand as though he'd been burned, and feeling certain in every fiber of his body that the stewardess had just been informed about the planes striking their New York targets.

For an instant, just one instant, Raed was clutched by the fear that he was *not* in a simulation. . . .

Murmurs were rising from the surrounding seats:

"What'd she mean?"

"Why aren't we taking off? Know what's going on?"

Raed rubbed at his hand, wondering whether stewardesses had actually acted this way on the real day of infamy. Two rows ahead and across the aisle, a man was listening to his cell phone, a shocked look dawning on his face. And in the aisle seat three rows ahead, a woman was standing, turning, walking slowly toward the back, moving as though she had arthritis even though she was only in her thirties. She looked directly at Raed when she came alongside him, leaned over him and repeated the same four words: "Never forget this day." Then she reached down to Raed's shoulder, but before she could touch him, the woman's arm elongated, slid away, there was a whirl of light and—

Raed was back in the deep-projection facility, hanging in the center of the projection cage, groggy and disoriented and fighting a desire to remove the harness, exit the cage, and ask to be returned to his cell in Lew. The veiled psychologist stepped through the bars beside him, gave him a thumbs-up to show his bioreadings were acceptable, wanted a thumbs-up in return—Raed was supposed to signal if he was up to continuing, ready for the next part of the program.

He didn't give her a thumbs-up. Instead he lifted his breather, gasped to her, "I thought you said the people of the past couldn't see me?"

"They can't," she agreed, tapping a note onto the slate she was holding.

The projection cage operators called out that the target-coordinates were recalibrated, and the cage was ready for a second "folding." Was Raed ready for a second "ghosting"?

"They can't see you," she repeated, covering her veiled mouth with her hand to remind Raed to refit his breather. "And don't worry," she assured him, "you'll get used to ghosting after another few tries." She slipped sideways out between the bars again, before turning back and adding, "You won't be harmed, Raed."

Who did she think he was? Raed wasn't afraid of a computer simulation. His hand still tingled from his brushed con-

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tact with the stewardess, but it was all a trick of the 'trodes lining his harness straps, all just a trick of the mind. He'd been conned into overreacting by all the holeo material they'd made him study, that's all. He was playing the game so well he was beginning to con himself.

But they could *not* send him into the past.

And he was *not* ready to give up. The thought of being driven back to Lew was deeply comforting—Cell #1 was the only place Raed felt safe, felt under his own control. But Cell #1 was also a cage more frightening than this cage, and after leaving it two nights in a row, Raed knew the crack inside him was yawning wider. He sensed the new need pouring through, throwing the balance of his desire in the direction of continuing these trips out of Lew, no matter what simulation they put him through.

The psychologist gave him the thumbs-up again, and in response Raed balled up the hand that had touched the stewardess into a defiant fist, and said into his breather-microphone, "I am ready."

And said to himself *only a simulation* as the universe around him shifted, slid, swirled into the tunnel of light—

—which widened to become a vast, impossibly wounded sky. It was the sky of some inhuman world wreathed in shadow, pierced only by shafts of weird blue light, and threatened by thunderclouds that coiled not with water, but with ash that rained down on a dead land.

Another *bump* as Raed fell back onto a patch of ground littered with jagged concrete shrapnel and twisted piping, which did not cut him; he barely sensed any sharp edges. Pushing himself up off this rubble was extremely difficult. Raed struggled to stay on his feet, see where he was. All round him lay a spaghetti-panorama of tangled wiring, twisted metal braces, giant steel girders scattered like logs, sections of shattered furniture—and *paper.* Crests and swirls of scattered pages, documents jammed between wiring, sticking out from shards of concrete. Suddenly a nearby swell of paper shot skyward as steam vented from the unsteady, uneven landscape. Raed had "projected" to a place where some war had been going on forever, by the littered looks of things—a place worse than any he'd seen before coming to America as a teen. Far worse than any part of Beirut, where he'd lived for a time as a small boy.

Unfortunately, Raed knew the name of this impossible place.

"Ground Zero," they'd called it.

He appeared to be standing on the island of Manhattan, on the spot where the Twin Towers had stood—and stood not long before he'd arrived, if the roiling sky was rendered accurately. This time he seemed to have missed 9/11 not by an hour, but by twenty-four hours. Smoke still hugged the rubble-strewn ground like patches of fog; distant figures drifted in and out of this fog, mostly firemen and policemen; a few were using search-dogs, trying to sniff out victims trapped under the rubble.

Raed himself smelled nothing. Not the smoke, not the scent of jet fuel that should have filled the air. Not even the singed-cinder aroma from the ongoing fires in the distance. *Thirty years, and they still can't program smells properly in computer simulations*, he told himself, but that was just his mind trying to deny what he was seeing: an inconceivably detailed landscape of devastation that extended for blocks in every direction, and a too-huge-to-fake sky above, drawing Raed's eyes up through bluish curls of smoke to the heavens. Out under the sky!

His soul had yearned for open sky for three long decades, but now that he seemed to be standing beneath one, he felt it was too awesome, too exposed, too heavy, too terrible to bear.

So he turned his eyes down to the tangled ground, and began to pick his way

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over to the only source of noise close enough to hear: a soft hissing emanating from the mist-shrouded bank of rubble directly behind him. Clambering back over a filing cabinet that might have fallen from the Moon—it was flattened like a stomped soda can—Raed started slowly across the damp ground toward this soft sibilant sound, presumably a very loud sound "in reality." Keeping his balance was complicated by the fact that he kept plunging through an insubstantial blanket of papers and paper ash, soot and concrete dust, getting his feet stuck in crevices beneath this visible surface-blanket, yet leaving no footprints in it, disturbing nothing he fell against, moving nothing he grabbed onto for support. At one point, he blinked down at a pair of eyeglasses, both lenses starred, crushed underfoot—

But not by him. Whoever had worn them was not *his* victim, no. Raed could sense the old defense almost rising to his lips, could almost hear himself saying it in a courtroom long ago. *America puffed itself too high in those two towers. Anyone trapped inside them had been trapped there by America alone, so they weren't* my *victims.* The old defense, the denial he'd dropped somewhere along the way, abandoned in an outer room of the labyrinth in Raed's mind, rooms away from the middle-aged man he was now. It all seemed so long ago, too long ago to feel clear on the subject.

Nothing seemed clear about 9/11, especially not here, not now.

But then a breeze he couldn't feel began clearing the mists ahead, revealing a looming shape just a few feet from him: the side of a huge fire truck, its designation ash-smeared but still visible. *Tower Pumper No. 146.*

Raed maneuvered round the front of the pumper truck, and dragged himself onto an adjacent mound of debris to get a better view of things. He was now level with the top of the truck's cab, and he could see the mist was coming from a hose being aimed from the crow's nest atop the pumper. A giant fireman in a soot-stained yellow coat stood in the center of the crow's nest like an indomitable statue, soaking down a fire inside a half-collapsed structure sixty or seventy feet away. A second fireman lay face-down further down the roof of the pumper, obviously exhausted.

Only two firemen for a truck this size?

It had to be less than twenty-four hours after 9/11; otherwise Ground Zero would be swarming with volunteer firefighters from out of state, even out of the country, if Raed recalled correctly. From his debris-hilltop, Raed turned and surveyed the entire scene, which was opening up as the imperceptible breeze cleared more spray and smoke and steam away.

The scene before him might have been some imaginary rendering of the end of the world. Smoldering multi-story sections of both towers lay strewn about like so many titanic accordions, while in the distance, Manhattan's financial canyons were on fire in a hundred spots. Closer at hand, the ground was draped with stretches of outer tower-walling, glittering and ribbed, resembling enormous metallic mats—or magic carpets used by giants from the *Alif Layla Wa Layla*, Jinnis that had vanished back into the sky, leaving behind explosive plumes of blue smoke. It was a vista more fantastical than any Shaherazade ever imagined. . . .

So unreal.

Yet this unreality was far harder to pass off as a simulation than the contained commonplace-reality of a passenger plane stranded on a runway. The interior of a 767 was a plausible space to model. But the exterior of New York, under an open sky? Around him the ground was seething, and crews of firemen and rescue workers were materializing from beyond veils of vapor swinging grappling hooks and pick-axes, each figure perfect and alive and real. Many of them disappeared into the gray-white

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crater in the center of this vast dead zone in time and in place.

The dead past.

Not rendered, not simulated.

Real.

Legs turning watery, going out from under him. Raed dropped helplessly onto the blackened husk of what might once have been a fine office couch.

Ground Zero.

Could his cousins Nazir and Sayf really have brought *this* about?

Could he really *be* here?

Real or unreal, Raed wanted this revisitation to end. He was more than ready to return to the present. And if the first projection back to the grounded plane was anything to go by, he wouldn't have to sit here long before they brought him out of all this. So Raed waited, watching the fireman atop the pumper truck hose down flames licking out of a crushed-accordion section of one of the fallen towers, and wondering whether he was seeing something that might be real, might be true: had the two men on Tower Pumper Truck No. 146 been working here through the night, fighting fires since the World Trade Center collapsed?

For an instant, the huge man working the hose lost his grip on it. A cloud of spray swept over Raed, and he swung his hand through the moisture without feeling a drop. *Not massive enough*, he thought, the science they'd fed him regurgitating an explanation for this flaw in the visual reality. *Things will appear both startlingly real and surreal*, the Muslim psychologist had warned him.

Suddenly the hose shut off altogether, and the weary fireman stumbled out of the crow's nest, tore off his goggles, wiped tears from his eyes—no doubt he'd lost many firemen-friends when the towers came down—then the man collapsed on the pumper's roof right beside his prone coworker. That's when Raed became aware of a prickling sensation, a cloud of *something* uncomfortably tingly swimming over him. . . .

Heat! Heat *was* able to "span the dimensional divide" that purportedly separated Raed from this past. Heat was cumulatively massive, Francis had told him—it had sufficient structure to transmit a force across N-space. Whatever the case, he was definitely sensing a radiation from the burning accordion-floors not far away—an itchy, uneasy chill. A cold and ticklish pressure, unlike any cold he'd ever felt.

So this was heat in the land of the dead, three decades back!

Raed shivered, on the verge of believing again, wondering if those two firemen really were lying only a dozen feet from him, unaware of his ghostly presence. He rubbed the edge of his left hand, where it had made that fiery contact with the stewardess. Human contact was one that *did* feel hot in these projections—too hot too handle, which was why Raed was being careful not to get too close to anyone this time around. He would not touch any of the people he encountered at Ground Zero, and he would not be touched by them. *He* was not responsible. *He* was not the twenty-four-year-old who'd helped two cousins bring the Twin Towers down. That boy was long gone, locked down in the dustiest, most unreachable part of the labyrinth of Raed's mind, the key to his pre-prison self thrown away ages ago.

So how could it possibly help him to see all this again?

But Raed had never seen Ground Zero the first time around, of course; he hadn't dared venture anywhere near it in the aftermath of 9/11.

A minute after the first fireman shut off the hose and slumped down on the pumper's roof, his resting companion slowly got up, climbed into the crow's nest, and started the hose up again.

Fifteen minutes later, this shorter, stockier fireman began to tire too, stepped out, dropped onto his back in exhaustion. Then the larger of the two men rose again, and took his place back behind the hose.

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Raed was left to imagine how many hours their tenacious routine had been going on. . . . After two more edge-of-exhaustion exchanges of duty in the crow's nest, someone else appeared atop the pumper, a track-suited citizen just visible climbing up the ladder at the far end of the truck. A journalist, Raed thought, or some lost local too distraught to go home. Someone foolish enough to show up without a filter over her mouth, at any rate. The woman stepped right up onto the pumper, reached the fireman lying prone on the roof before her and was so overcome she crouched down beside the man, and abruptly embraced him. An emotional show of gratitude for his efforts to extinguish what was left of the angry fire from the jets. . . .

Or maybe she was hugging the spent fireman just because he looked like he needed it.

Raed didn't have to wonder whether this sort of thing had actually happened after 9/11—he'd seen it happen, in the streets of Brooklyn just hours after the towers came down. He'd seen strangers walk straight up to a weeping member of New York's Finest, and spontaneously embrace the policeman. New Yorkers had reached out to each other in ways that had surprised Raed that day. . . . Again falling spray clouded his view of what was going on, Ground Zero became a swirling gray, began sliding away, and—

He was back, praise be, he was *back*.

Pulling off the breather-mask, Raed gasped in mouthfuls of air and blinked out through the bars of his cage at the hundred-odd other projectors beyond the pane of Plexiglas, writhing and walking in their suspended states, ghosting back to other places and other times, if all this was to be believed.

No, no, *no*, he *would not believe*. Turning back to the team assisting him, he saw the veiled psychologist saying something to him from outside the cage, and again offering him a questioning thumbs-up, wanting to know if he was okay.

Raed gave her a thumbs-down.

She entered the cage immediately, her eyes alight behind the burqa—with concern? With contempt? "Are you unable to continue?" she asked him, fingers poised over her slate to make another note.

"Can't you project me somewhere else?"

"Perhaps." She tapped in her note, glanced back at the researchers manning the controls, shrugged, then said to Raed, "I'm obliged to remind you: you can withdraw from our program at any time, if you don't feel up for it."

She made it sound as though quitting was the obvious choice. Maybe she *expected* him to give up, go back to his cell in Lew and simply rot away for the rest of his days. . . . But the crack that had opened deep within Raed was wider now. It was swallowing the walls he'd built to hold the outside world out—his mind's labyrinthine safe-house was losing whole rooms to that yawning insidious divide-inside. So he didn't know if he *could* just give up and go back. It was surely not so easy as this wide-eyed woman made it sound.

Anyway, he was not about to give up.

"Send me where you will," he told the woman, waving her dismissively out of the cage, all the while thinking *please let it be just a simulation!* Bracing himself again as the beams shimmered on and the rift reopened, twirling the cage's bars away, tunneling him back to—

A living-room in someone's house.

Raed dropped softly onto a pine floor in front of an antique cabinet, bounced once, fell forward onto hands and knees, and looked around at the spindly legs of furniture handcrafted from some dark wood. He got to his feet easily, but saw no one down the hall of the house's ground floor. Was he in some suburb of

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New York? Raed peered out a shaded front window onto a lawn gleaming in the Sun. The street at the end of the lawn looked broad and sleepy under large trees; there was no traffic, and the houses across the street were widely separated.

He doubted he was in New York.

The cage-operators must have heard the request he'd made to "project somewhere else" through his breather-microphone. . . . That, or they'd *really* missed the target this time.

No, it's just a simulation.

Again, the light filtering through the trees onto the lawn suggested it was early morning; so did the dew still gleaming on the grass. Perhaps there were people still upstairs, getting ready for work. Raed cautiously made his way up to the second floor, and peeked even more cautiously into each of the floor's rooms: guest bedroom, master bedroom, a spacious bathroom, a small office. The house appeared to be empty.

A window at the back of the office was partially open, so Raed slipped inside the room, glanced through the window over a side lawn at a neighbor's clapboard house, then tried to put his arm out beneath the window. He had to push his hand right through the mesh-screen meant to keep the bugs out; he felt only a little gluey resistance. He got his arm completely out, but that was all—the window, presumably left open for air, wasn't open enough for him to squeeze his head or chest out. And as hard as Raed pushed on the window-frame itself, he couldn't budge it wider. He couldn't move things in this world.

So leaving the office, he looked in again at the windows of the guest bedroom and the bathroom, found them all closed. The master bedroom at the back of the house had a big window, but it was closed too, and curtained for privacy. . . . Lying on a big bed beneath the window was a cream-colored blouse, a black skirt folded neatly, a frilly pink bathrobe. The sight of the clothing reminded Raed powerfully of Haifa, his wife. His eyes went helplessly to the framed photo on the bedside table, which showed a couple hugging on a beach. The woman was laughing. The man was bent to kiss her neck. Almost certainly a photo of the couple whose bedroom Raed was standing in—and placed on that table, he guessed, by the woman, as a proud memento of her happiness.

No such photos of Raed and Haifa existed, not even in his memory. What Raed remembered most when he thought of Haifa was her fear of him. He hadn't treated her well, especially in the final years, when his cousin Nazir's beliefs took a stronger and stronger hold over him. Turning away from this thought, Raed caught a shaft of sunlight streaming through a partly-open door in a corner of the bedroom. Stepping over to it, he discovered a bright bathroom, the morning Sun pouring gloriously down through a big skylight. After ensuring the bathroom was empty, he eased round the door into the Sun-filled space—only to find more woman's things arranged on the long counter. Skin creams, make-up, hair clips, a big brush with fine black strands wrapped about its bristles. . . .

To his surprise, Raed found himself in the grip of an unbearably lonely longing he'd thought he'd gotten rid of ages ago—as though he'd just eased round a partially-open door into a room in his head he'd thought he'd lost the key to. Mixed in with the longing was an intense sense of lost opportunity. For Haifa had edged more and more toward moderation in America, whereas Raed had arrived a moderate and only became a devout in those last few years before the towers came down, under Nazir's tutelage. And after the towers fell, after his fear grew and his family was taken from him, Raed gradually lost his devotion altogether.

So it was unpleasant now to recall how he'd fought to keep Haifa under his

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thumb, forcing her to accept a fundamentalism he hadn't believed in when they'd married as teenagers. The innocent boy he'd been became a kind of monster, a fanatic to be feared during those final years of freedom, before he'd melted down into something else entirely during the first decade of imprisonment.

Melted down into *what*, though?

Raed had been careful not to step in front of the bathroom's long mirror. Now he took a look, and saw—

No reflection of himself.

It was the eeriest thing, as though he was . . . what did they call it? A vampire. Raed was a kind of vampire in this past.

But if he was supposed to be back in September of 2001 again, wouldn't he then look young again? Raed's hands were still veined, mottled with middle age. He ran one hand through his hair, tracing the receding hairline, then ran the hand back down over his bony brow and over the breather-mask to his chin and throat. Clean-shaven, as he'd been back in 2001, to attract less attention in America. For a while, he'd grown a proper beard in prison. But a few years later, Lew started handing the new shaving gels out to prisoners—offering the prospect of a wipe-on, wash-off mirrorless shave—so Raed went back to clean-shaven again. He'd grown too used to the routine, during the years leading up to 9/11. Routine was the key to staying sane in prison.

Routines like avoiding mirrors.

Raed was glad he cast no reflection; he hated to think what he looked like now. A ghost of the young man he'd been for sure, his thick dark hair turned thin, his strong face turned gaunt, the high cheekbones of his people sticking out too much now. . . . But his fear of mirrors wasn't really about becoming old, was it?

Another surprising memory breaking free from a locked storeroom in his mind: Raed realized he'd started avoiding mirrors *before* he went to prison. He'd avoided them immediately after 9/11 because he'd looked so awful. He'd looked twisted, like a monster even to himself—

Raed wriggled out of the narrow bathroom door and fled the bedroom, almost tumbled back down the stairs, forgetting how tricky walking was on an intangible carpet covering soft slippery wood beneath. When he reached the bottom—and got back to his feet—he began looking for a way out, wandering through the handful of rooms; living room, dining room, the long hall with its open coat-filled closet, a downstairs bathroom, a cozy den with a fireplace. Each of the rooms exhibited a down-to-the-last-detail visual authenticity, and each was a living space that made a mockery of the concrete cell he called home. None of the rooms, however, offered him a way to get outside.

Raed felt the wholly believable reality of this American home closing in on him, reducing the number of rooms for him to hide in in his mind.

The last room on the ground floor he managed to squeeze into was a blindingly bright back kitchen. One whole wall of the kitchen was floor-to-ceiling windows, letting in the sun and letting Raed look out over a patio and a long yard. Raed walked right up to the windows—one was actually a glass patio-door—and gasped at the vista before him: beyond a picket fence at the end of the yard, the land dropped through rolling green hills down to a small steepled village about a mile away. The village stood on the edge of a sunlit ocean, the waves sparkling off to a distant horizon.

Nothing Raed had seen in thirty years looked more like home!

It was not the home he'd been born into, a small village that had stood near waves of desert sand. No, this was the American ideal of home: a peaceful village with quaint clapboard houses and colonial buildings, like something out of a story book—a story Raed had lived for a time. He'd been a preteen when he'd

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arrived in America, and had lived all the years of his adulthood on American soil, so he knew its stories, knew its dreams. . . .

The dream-house he was in now looked like it might be on the shores of Rhode Island. He and Haifa had driven along that shoreline after Raed finished a bit of "security reconnaissance" at the airport in Boston. During their seaside drive, Raed had derided the storybook villages they'd passed through. Now he could not remember why the sightseeing had left him so unimpressed, or why had he'd been so eager to obey the organization ordering him to Boston in the first place. He must have been hiding in rooms in his head even before he'd reached prison. Hiding from the reality he'd lived in, hiding in a seventh-century corner of his mind and ignoring the twenty-first-century America around him. . . . But that was another Raed, not the middle-aged ghost from the future standing in this kitchen, looking with longing on the village down below, a wholly magical place Raed was ready to believe in.

He felt his throat tightening with emotion. He *wanted* to be back in this past, simulation or no simulation. He wanted to break free of the harness holding him to 2033 and wander down into that peaceful perfect village, buy a coffee in a shop, sit and listen to people talk, and never look back.

They'd said if he participated in their program he would get to see "the outside world again, in a way." Is this what they'd meant? If so, the psychologists had cheated him. The scene before him was so pristine it was heartbreaking to look upon. And Raed couldn't so much as step out to the backyard.

Then he remembered what the researcher Francis told him about volunteers sticking their hands through glass. So he began to try, pushing hard against the glass of the patio-door, and gradually feeling his fingers sink into a surface like glue that had almost hardened. But after several minutes, he'd only managed to get the tips of two forefingers to peek through the other side of the glass. And he did *not* want to be stuck here if people arrived, came into the kitchen, and brushed up against him.

As he stood drawing his fingers back out, Raed glanced around the kitchen, and saw a calendar facing him from the nearest wall. It was open to September 2001, and on the week of September 11 the words *TOM IN L.A.* were marked across several days. The calendar could not tell him what day this was, of course; but Raed knew, oh, he knew. He turned back to the glass door, focused on freeing his fingers. That's when he noticed the reverse-reflection of the digital clock on the stove at the back of the kitchen behind him. He turned completely around to see if he was reading it right.

8:45 AM.

One minute to go on the last pristine morning of the world. One minute before the first of the four planes would hit its target. Raed drank in the view beyond the glass door for another few seconds, wishing this last moment could last forever, bracing himself for . . . *8:46 AM.*

Nothing happened. Naturally, New York was far from Rhode Island. His fingers finally popped free, and he stood there flexing his hand before realizing he was hearing a soft buzzing from somewhere. The front doorbell? No, it had be something close, in the kitchen. Raed walked around the room, and ended up beside the phone, which was ringing really loudly when he was right beside it. The ringing stopped, and an answering machine adjacent to the phone clicked on. A woman's voice announced, "We're not here, but you can leave us a message." Then the caller began to speak:

"Angie, I'm . . . it's Tom," a male voice said, and Raed's eyes shot to the calendar. *TOM IN L.A.*

"My flight's been hijacked," Tom con-

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tinued all too calmly. "I'll try to call again, but don't know if there'll be time. Whatever happens, Angie, know that I love—"

Raed leapt away before he heard the end of the message, knowing the sound would drop off faster than it should—and it did, the rest of Tom's words to Angie unable to reach across a foot more of kitchen floor. He backed all way into the patio door, disturbed and disbelieving. How could a man caught on any of those planes have been so calm?

It was a question Raed had asked himself over and over the day *before* 9/11. That was the day he'd driven his cousins across the state border into Connecticut and booked them into a motel on the Massachusetts border for the final night of their lives. Chipmunk-cheeked Nazir. And thin-faced Sayf, always skeletally thin, more than a little obsessed-looking. But Sayf and Nazir had both been calm and controlled during that afternoon drive through the Connecticut countryside, mentally preparing to sacrifice themselves when the morning came. They'd met with their cell-leader less than an hour before the long drive began, and had been let in on the target of their mission a little early because their leader trusted them. Nevertheless, Nazir broke down and let Raed in on their terrible secret before they reached the motel because Raed was kin, the last member of their family who would see Nazir and Sayf alive. After his cousins booked into the motel under assumed names—the names later published under their photos in the papers—Raed stayed in their room with them for a few hours before driving back home to Brooklyn alone, wondering all the way how his cousins could have been so *calm*.

Raed saw the light on the answering machine start to blink. He walked toward it slowly—wanting to be sure it was finished recording—then stared down at the damned machine, hoping the cage-operators didn't make him wait in this house until Angie came home and listened to what was on it. But at least, he thought, as the kitchen began to slide sideways away from him, at least Tom had said what needed to be said to *his* wife—

Back, back in the present, and breathing hard.

Raed shook his head, wanting to rid himself of the sad end to such a beautiful dream, a beautiful simulation. He gazed blearily through the yellow bars, saw the hundred other spherical cages beyond the Plexiglas, scattered across the main projection arena. A hundred other volunteers were hanging in their harnesses, looking strangely blurred, squirming and swaying in midair. Folding back across N-space to a hundred lost moments in history?

It can't be.

"Feeling all right, Raed?"

The woman psychologist was already in the cage below him again, waving a hand before his eyes to get his attention.

He dragged the breather down again.

"I feel. . . ."

"What?" She waited, one hand poised over her slate.

Lost, he wanted to say. *Full of lost opportunities.* Raed had heard passengers had contacted their loved ones from those doomed planes, but . . . *he* hadn't ever contacted Haifa to tell her his own feelings—because he hadn't realized how strong his love for her really was until too many years had passed, and it was much too late. So the acid dose of heartbreak filling him now was as much for himself as for the man who'd left that bittersweet message.

Raed peered down at the psychologist, knowing he was already losing tonight's game badly. "You can't make me believe," he said to her, no longer wanting to play any more games. "You can't convince me I'm really seeing the past, I don't care what you show me."

The woman nodded, tapping away at the slate. "What you believe is entirely up to you. And what you do where we

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send you—that's up to you too."

"What *is* there to do," Raed retorted, "when I'm just as cooped up back there as I am in Lewisburg?"

"You really want to find out?"

Raed let out a long shuddering breath, unsure whether this veiled and proper young woman sounded hopeful for the first time—or whether she was trying to warn him about what was coming next. But he was sure of the answer to her question. Some part of him *did* want to find out. Something was stirring down in the crack through the core of his being: an ashen yearning to go back there and confront whatever they would show him.

"Yes," he sighed. "Send me again."

The look in the psychologist's wide black eyes subtly changed. Surprise? She whirled, exited the cage, and conferred with the two operators sitting at their consoles. And Raed closed his eyes, knowing it didn't really matter where they projected him to this time, because what he'd told the psychologist was the truth: he wouldn't, couldn't bring himself to believe that he was folding through "N-space" back to—

New York City, an empty sidewalk.

Raed dropped onto the walk as it appeared before him, caught his balance, steadied himself on his feet, and looked around. He was not in Manhattan, not in any of the busier parts of the city. And he was finally outdoors! No walls to hold him back, no mounds of rubble to block his progress. Free to go where he pleased.

Raed started up the quiet side-street he was on, heading for a larger cross-street so he could figure out where he was. He passed the steep steps of a row of four-story walkups. One of the boroughs, for sure. This was the New York he remembered, glad to have an image of it to replace the desolation of Ground Zero. . . . Blue skies above, a breeze rippling the leaves of a haggard tree on the corner. An autumn morning, for sure. Back in *that* morning once more? Before the attacks occurred? After?

The signs at the end of the street told him he was back in Brooklyn, on a corner several miles from where he'd lived; a vaguely familiar corner. Raed spun around, orienting himself. The East River had to be just behind the row-houses that were blocking his view of the World Trade Center. He couldn't see whether the Twin Towers were still standing—but if they were, he could walk around the block and head down to the riverside, maybe just in time to watch the planes striking their targets.

Was that what the projection operators wanted Raed to do?

Surely it would do him no good whatsoever to witness the destruction of the towers all over again. He'd seen those images a hundred times on TV, along with everyone else. Surely it would be senseless to waste this precious chance to walk the world he'd lost by going down to the river to gawk. The Twin Towers were not his victims anyway—they were the West's victims, America's victims. . . . Raed started walking west, keeping the Trade Center's location behind his back. His eyes kept turning to the perfectly clear skies, searching for low-flying passenger jets. He prayed he wouldn't see any. Stopping at another cross-street to let a yellow taxi roll by, he felt certain he knew this neighborhood. Only a few people were out on the streets, and those that were hurried along as though late for work. The Sun looked too high to be early in the morning. What time was it? What *day* was it?

A *New York Post* box coming up on his left. When he reached it, Raed hunkered down on his haunches, and saw something on the cover page about "Ban on Cell-Phone Use While Driving."

But the date on the newspaper was 9/11, all right.

He walked on, hurrying now, spying a tiny park across the street not much farther ahead. Not much more than a grotto, really, but Raed began jogging to-

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ward it, feeling sure the visually stunning simulation of a New York morning he was moving through was about to change. All he wanted was a few moments of peace sitting beneath those trees before this blissful reality was yanked out from under him.

And then it hit him: he was near Basma's Islamic daycare and prayer school, a small building at the other end of the little grotto park. No wonder all this looked so familiar.

Basma.

Raed broke into a run, remembering the promise made to him—that he might get to see his daughter again. Was this what the rehab programmers meant? Then they'd tricked him—they'd known perfectly well he'd hoped to see Basma all grown up. Raed ran for the school all the same, wanting to see his little daughter in this all-too-perfect recreation, suddenly wanting it very badly. Wanting to know once and for all.

As he ran up the block, something happened to the sky. A cloud of confetti appeared from over the four-story walkups on his left. Snowflake-sized particles were fluttering down onto the sidewalk ahead of him, some larger pieces of paper floating down too. . . . Documents! Memos and letters and receipts from all the way across the East River, fallout from Twin Tower offices. The paper cloud began to litter the tops of trees in the grotto-park as he passed it.

Just ahead loomed the Islamic prayer preschool, all the toddler-students dressed in their jackets and milling about on a fenced-in patch of tarmac alongside the school's front steps. Half of them were roped together.

What was going on?

Raed reached the wrought-iron fence, and found the school's entrance-gate closed. He struggled to get over the tall black bars but kept slipping down, unable to get any purchase with his shoes. There was no room for him on the crowded tarmac beyond anyway, so he strode impatiently around the fence, hearing the chaos of chattering and squealing, trying to spot Basma among the children. In the midst of the preschoolers stood a teenage girl dressed in salwar and kameez, gaping up at the sky in astonishment; a more resourceful Muslim girl was untying the rope tethering several kids together. Of course! The young teachers had been caught preparing the children for their eleven o'clock walk through the park. No TV was allowed inside the conservative classrooms, so neither the children nor the adults looking after them had any idea what was going on yet.

But where was his Basma?

The thickening confetti-rain was making it harder to see who was who. Unleashed four-year-olds danced through the downfall, turned their tiny faces upward, and grabbed at papers. . . . At last Raed spotted a child smaller than the rest, squatting with tiny hands on knees in a familiar blue raincoat, her head turned to the ground, looking curiously at the scraps of paper lying there.

Heart in mouth, Raed knelt outside the bars, as close to her as he could—but the girl scrambled away into the center of the crowd, vanished for a moment, and reappeared duck-walking toward him with an ever-so-Haifa-like look of concentration, creased brow, mouth drawn tight, sucking her teeth *exactly* as Basma so often did during the three years he'd been father to her.

God and the Prophet within, what *am I seeing?*

The child stopped just a few feet from him, crouched just as before, reaching now for a big file-folder that had just landed, its edge smoldering.

"Don't!" he cried out. But the Basma before him did not pause, did not hear him, could not see him. Raed thrust an arm through the bars, and tried to snatch her tiny fingers away—too late: she'd grasped the burning edge and immediately let go. She began to cry, lower lip shooting out *exactly* as it had on

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the day Raed was taken away from her forever. He had not seen Basma since his trial, not until this very moment. . . .

For Raed knew in his heart of hearts he was *actually seeing* his daughter now.

His mind reeling, the world whirling, Basma blurring as she drew back, plopped onto her bottom—

"*Please*," he gasped into the microphone of the breather-mask, "I *believe*, don't bring me back. . . ." But it was only his own tears blurring things. Raed was still there, still clutching the iron fence in September of 2001, inches from his *real daughter*.

Another teacher burst through the school's side-door, teary-eyed herself, shouting something to the teenage girls standing among the children—something about parents coming early to take their children back, the city under attack!

Basma's wailing finally drew one of the teens to her side. The girl scooped his daughter up, and Raed leapt to his feet, reached as far he could over the fence, Basma sobbing over the young teacher's shoulder *right in front of his eyes*, his hand almost touching her hurt little fingers, almost. . . .

"We put a bandage on that?" the teacher asked, and little Basma nodded through her sobs.

Raed watched the pair disappear through the school's side-entrance while the other two teens rounded the rest of the children back inside, out of the paper rain. "I believe," he moaned again, tugging his arm from between the bars, sinking to the paper-littered ground. "Now I believe." Raed had not allowed any cameras in his house during those last paranoid years of freedom; he'd certainly forbidden any video footage to be recorded of himself or his family in those years. And the Islamic daycare and prayer school could not afford any video equipment . . . so no one could possibly simulate the Basma he'd just seen.

Raed knew he was *actually kneeling* outside her school.

"Be merciful—let me stay," he prayed aloud, hoping the projection operators would hear his words in the future. "Let me wait here and see her again." But the wrought-iron bars of the fence were already sliding out of his hands. The school building was beginning to swirl into the confetti-sky, and he was starting to tunnel back—

To the present.

Hanging in midair in the yellow cage, his breath still hitching with emotion. Had Basma's hand been bandaged when Raed picked her up from the pre-school that day? He couldn't recall, and he doubted he would have noticed. That day Raed had been too busy worrying about being tracked down, accused, arrested. He'd spent the entire day wondering how to ensure *he* didn't end up getting burned by the backlash to the World Trade Center attacks to notice whether Basma had already been burnt or not.

Not his victims?

Surely little Basma was his victim, if anyone was—and a couple of bandaged fingers was of little consequence compared to the inevitable consequence of losing her father. . . .

"Here." The veiled psychologist was standing in the cage below him again, holding a cup of water up to Raed. "Drink this," she said.

He tugged down his breather-mask, a little embarrassed as he wiped back his tears, recalling how the fireman at Ground Zero had looked when *he'd* pulled off his goggles to wipe away tears. Raed had been there—he'd *actually been* to Ground Zero!

And now, like that fireman, he just wanted to get out of the harness and throw himself down on the ground. "I wanted to stay," he complained to the psychologist, more than a little embarrassed by his earlier profession of disbelief to her. "Why'd you have to bring me back so soon?"

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"Because you've more to see tonight, more to do. Here," she said again, "you've got to be thirsty—"

He knocked her hand and the cup aside. "I don't need water, I just need to go back—" He broke off, seeing her reaction, the flash of intensity in her wide-set black eyes. Because Raed's fingers had briefly brushed hers?

"You'll feel thirsty, where you're going next," she warned him. Picking up the cup, she slipped out through the bars.

And Raed slumped back in the harness, acceptance sweeping through him. For the first time tonight he did not want to be *here*, where he was middle-aged in a spherical cage. Better to be a ghost lurking in that past again.

Outside the yellow bars the psychologist—a grown Muslim woman whose hand he'd reached out and touched, just in case—watched him watching her, then she tapped something into her slate and turned away, slid away, vanished around an impossible bend in space that opened into—

A deep canyonlike street.

Downtown Manhattan, on the same bright sunny morning he'd ghosted to the last time—only *this* time Raed could hear an unearthly rumbling and he could see people running away from him, fleeing for their lives before his eyes. He whirled. High in the sky above him were the Twin Towers. The South Tower, only a block away, was erupting from the top down.

Raed staggered backwards, gaping at the giant cloud of dust and debris surging forth from the building his cousins had crashed into, like a storm being injected into the blue sky at tremendous speed. He swung around, and a man sprinting by bumped against him—

TERROR-ADRENALINE-ANIMAL URGE TO RUN!

Raed obeyed the fiery emotions transmitted by the man's touch, hurtling himself across the street and around the corner of a nearby building. At the end of the road he'd turned onto, people were throwing themselves over the railings into the Hudson River—hoping for safety in the water? Raed veered in another direction, down a narrow lane and out onto a broader side street, the rumbling behind him swelling along with his fear. To his amazement, he saw a crowd of people standing in the distance, all their faces turned up like sunflowers in the instant before they, too, began to run.

And then, all at once, everything Raed could see vanished—the distant crowd, the canyon-walls of the high rises and the street itself, all swallowed in dust and darkness that felt like the end of the world.

This time he'd ghosted back to the world he'd lost at the very moment it was lost!

It was so dark on the street he could only make out shapes a few feet in front of him. It seemed impossible that just seconds ago it had been a clear blue-skied morning. . . . Fumbling his way along a building-front in the direction he *thought* he'd been heading, hearing a tinkling sound—glass shards falling out of the sky? Windowpanes shattering in the storefronts around him? Either way, the sound had to be much louder and closer than it seemed. He caught glimpses of big debris-chunks crashing onto the pavement to his left, and burnt paper and concrete dust swirled thick as sleet.

The darkness began to yield to a wintry dimness—like a strangely dry snow squall in Manhattan—and Raed reached the next cross-street corner just in time to witness a hail of burning shrapnel striking a car-filled parking lot across the street. Cars began bursting into flame.

He dove under a parapet protecting a building front-door, reminding himself the projection-team claimed he couldn't be harmed. But Raed knew he could feel forces in this past, and he didn't want the force of any of that shrapnel striking him. So he sat under the parapet watching cars ignite, one after another. In-

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credible! As though missiles were being launched from the burning windows of the surrounding high-rises. . . . Suddenly a large oblong shape loomed out of the dust-mist hanging over the street—a fire truck loaded with men who leapt off, rushed into the parking lot, fighting back shadows and smoke as they searched for people trapped in burning vehicles. Those firemen were crazy to charge in there!

Looking for a safe escape route, Raed noticed a lane leading from his parapet-covered patch of sidewalk back into a plaza behind him. He ducked through, rounded another corner, and felt his way along the lee of another wall. A set of double doors just ahead of him burst open, the light from inside the doors revealing men in overcoats stepping forth, rifles at the ready. The armed men—not police, possibly FBI—formed a ring outside the open doors and peered into the murk, as though looking for whoever was to blame. Looking for Raed, who was holding his breath, flattened against a window-well just feet from them. *You already caught me*, he thought. *I've already served thirty years.*

Now more people were piling out through the doors into the armed cordon. Older officials wearing suits, fire hats, air-filters—not chiefs, possibly fire commissioners—all of them lucky to be alive in a command post this close to the Twin Towers. And all of them alternately shouting into hand-held radios, then listening for a response, shouting, then listening, throwing off waves of voices Raed could hear without making out individual words. In the light streaming through the open doors, he saw the despair contorting their faces. The commissioners weren't getting any responses from the fire crews in the collapsed South Tower.

Then a familiar long-faced man in wire-rim glasses strode into the crowd of stunned city officials, issuing commands, arguing with the armed detectives who seemed to want the cordon to stay put. But the long-faced man sent the party off across the dust-clouded plaza in the direction, Raed suspected, of the Trade Center.

Raed suddenly knew exactly who that man was.

The Mayor of New York City.

Heading to Ground Zero only minutes after that nightmarish zone had formed? Or steered to safety by his armed protectors? Raed took off in the opposite direction, rounded another corner, found his path blocked by a steaming shape taking up the sidewalk and half the road in front of an abandoned fast-food outlet: a jet-engine turbine.

From Flight 175? From Nazir and Sayf's plane?

The turbine was so dust-whitened it looked like the engine of some ghost-plane. Tingling waves of cold heat were coming off it, so Raed gave it a wide berth and hurried on, only to be slowed by more dust-and-ash-cloaked obstacles as he fled out of the south end of Manhattan. Twisted stick-shapes that had to be melted office chairs, an overturned desk in the middle of a sidewalk, a huge tire, all made visible by the fires sprouting in nearby buildings, offering Raed a weird torch-light to light his way. . . . Incredible. He'd seen TV images of Manhattan after 9/11, but they failed to capture the scope of the devastation. In his wildest dreams, Raed never thought his cousins could cause so much damage to the city.

And in his wildest dreams he'd never imagined he might "time travel" back to see it with his own eyes! This time he'd ghosted back to *before* his visit to Basma's school. Perhaps as much as an hour before, if he remembered correctly. Somewhere in the unseen sky high above him, a file folder from the South Tower was being carried by air currents over the East River, drifting down toward the little prayer school tarmac. Basma hadn't burnt her fingers *yet*. She wasn't a victim *yet*.

But Raed was stepping over victims

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wherever he went, shrouded forms that seemed to be sleeping in the middle of the streets—forms he didn't want to think about. Nazir's victims, Sayf's victims. Not *his* victims.

After almost falling onto one of those shrouded figures, Raed scrambled up an embankment onto a higher boulevard. Disoriented, he tramped along the boulevard in a direction that seemed a little less dusty. But within minutes, smoke from the spreading fires behind him descended on the boulevard, thickening the dust-haze. Raed passed an EMS triage team working on a wounded woman already partly buried beneath the paper-ash fallout; the rescue workers were trying to revive the woman and keep themselves from passing out at the same time, handing a single oxygen mask back and forth.

He gave the team as wide a berth as he'd given the jet engine, wanting to avoid more physical-contact discharges from distraught New Yorkers. It was traumatic enough just trying to escape the shrapnel-fires. . . . He wasn't the only one trying to escape, of course. After hopping out of the way of a beaconless ambulance—its roof littered with paper and its wipers rapidly swishing—Raed noticed a few other ghost-shapes trudging along through the haze. People with grime-covered faces, holding pieces torn from their own clothing over their mouths, coughing soundlessly.

Raed felt like coughing too, even though he wasn't breathing any dust in. Most of it was falling right through him, only the largest paper-flakes hovering on his clothes for a few seconds before slipping off. The "masslessness" of the falling dust made it easy for Raed to avoid and quickly out-pace the real downtown-refugees he encountered—because they were forced to slosh slowly through the paper and ash pooling on the street, which was already several inches deep. Raed hurried on, undeterred by the debris build-up, always drawn in the brightest direction, even though the sources of brightness turned out to be shops and services with their doors thrown open. Each open doorway offered a consoling peek into an interior of clarity and detail—a reminder that the New York Raed had seen for a few seconds at the very start of this projection still existed, hidden behind all the hazy detritus.

In the beaming entrance to a footwear store, he saw a man handing out free running shoes to women wandering by in stocking feet, unable to walk through miles of fallout in their high heels.

In the rear door of a restaurant-supply firm, he saw a teenage boy passing out wet towels to everyone who stepped up for one, so people had better air-filters to breath through.

In the arched portal of an old church, he saw women pouring cups of water and lemonade for passers-by. The church was getting crowded because the people coming up for drinks were stepping inside it, kneeling down in pews, bowing their heads. Raed paused across the street from this softly-glowing scene, watching the parade of dust-whitened ghosts gratefully downing lemonade and water, and reaching up to his own throat. He'd felt thirsty from the first moment the debris-cloud enveloped him, and his thirst had grown worse with every passing block. It wasn't just the exertion of a long walk. It was the *look* of ash-laden air all around him, the *sight* of coughing, choking civilians stumbling through the streets. The psychological dryness was getting to him.

But what was really getting to him was the fact that he was *actually experiencing* what it had been like to make an escape from lower Manhattan the morning of 9/11. Because he was *actually here*, witnessing all this just as it had happened—or rather, as it *was* happening. A cement-mixing truck rolled slowly by, a dozen dust-coated Wall Street suits clinging to its sides. Raed followed it for a bit, then turned onto an empty

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side street he thought might take him in the direction of the Brooklyn Bridge.

That's when he spotted the strange pair of New Yorkers sitting on the stone steps.

What was strange about them grew more and more obvious as Raed walked toward them: one was a man so thickly coated in dust and ash he resembled a statue huddled against the railing of the steps—he was clearly in serious trouble, gasping for air, mouth hanging wide open and taking in more dust. The other was a woman who'd clearly just come out of the building the steps led up to—she had only a bit of dust on her, and she was holding the dying man, her head tucked onto his shoulder as though he was an old friend she'd found collapsed outside her door.

The strange thing was *she wasn't helping him inside.*

"Get him off the street," Raed suggested as he passed the pair, knowing he wouldn't be heard. But he thought he saw the woman's eyes move up from her companion. He thought he saw her eyes following him up the narrow street.

Raed halted. Turned back. It was hard to see—he had to squint into the driving dust. Was she really looking over at him?

He approached the steps cautiously, still unwilling to be touched by these people, but getting close enough to see the dying man's eyes were rimmed completely red, bloody coals in his ash-whitened face. And he was close enough to see the woman's NYU sweatshirt, a red ribbon pinned to her collar. She had her eyes closed now, head tucked back on her companion's shoulder again.

He must have been seeing things. "Don't you know your friend is dying?" Raed muttered, surprised to find himself thinking another death would be needless. . . . The woman shielded her eyes against the falling dust, and peered up at Raed.

He lurched back in shock. "You *can* see me, can't you?"

But just then an accumulation of dust slid off the ledge above the steps, engulfing the pair in a swirl of white that transformed into a blurred tunnel, pulling Raed back to—

The yellow projection cage.

Raed peered out through the bars at the two Lew guards in one corner, the two cage-operators behind their consoles, the medic looking over the operators' shoulders . . . and the Muslim psychologist slipping in through the bars to speak with him, again bringing him a cup of water.

This time Raed accepted the cup, lifted it to lips that *felt* parched, his throat dry as bone. After gulping the water down, he told the psychologist, "Someone saw me that time." Then he described the woman he'd seen sitting on the steps.

"Sure she wasn't looking up at the ledge-dust about to drop on her friend?" The psychologist removed her slate from a pocket, tapped in something about Raed's claim.

"Are you *sure* people can't see me in the past?"

"I studied the same materials you did," she replied. "Light only has 'one-way transdimensionality,' so it only flows out of the past into an N-space fold, but—"

"Doesn't flow back out of the fold, yes, yes," he said, wondering if he'd been mistaken about where the woman in the NYU shirt was actually looking. It had been pretty hazy back there. And pretty scary at moments.

"There *are* two-way interactions," the psychologist added, pocketing her slate again. "But all are mass-related, I think. And light doesn't have much mass. . . ."

That reminded Raed: those big chunks of mass falling from the sky at him. "And no volunteer has been injured by two-way forces—not even gravity?"

"Two-way interactions are 'weak-

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strong,' so I'm told. Weak from you onto the past—"

"And strong from the past onto me," Raed finished, raising his eyebrows at her. That's precisely what bothered him. He handed back the cup, accidentally touching the psychologist's fingers again—and wishing he could receive some contact-discharge from *her* so he'd understand what she was feeling. She was, after all, about his daughter's age.

"Strong or weak," the psychologist told him, "the worst any projected force can do is render you unconscious, which will immediately pop you back here. So there's nothing to fear. Keep that in mind," she advised him, "your next ghosting's going to be a lot more challenging."

Again he said, "Send me where you must," trying to sound dismissive to hide how apprehensive he was. But after the psychologist exited the cage, Raed took a deep breath, wondering what part of 9/11 he was about to experience now, watching the yellow bars blur as the fold formed about him, and N-space wrapped him back to—

A darkened stairwell strewn with chunks of drywall and concrete, a smoky haze in the air.

Raed lost his footing as he dropped onto the steps, slid down onto a landing, and ended up sprawled before a steel door in the landing's opposite wall. The red glare of emergency bulbs illuminated words printed across the door:

WTC
BUILDING 2
FLOOR 82

Raed was high up in the South Tower some time *after* Flight 175 had crashed into it!

The door to Floor 82 burst open. Two men shoved through, forcing Raed to scramble back to avoid being bowled over. The men hurried onto the shadowy flight of steps leading below. And Raed fell in behind them, wondering how much time was left before this building came down. He was fairly sure it had collapsed about an hour after the crash . . . which meant he had less than an hour to get down *eighty floors*.

But he kept falling in the stairwell. Where the masslessness of paper and dust had played in his favor on the streets, here the low friction of his shoes on the darkened steps and the more tangible clutter of concrete shards made it difficult to stay on his feet. Raed had a hard time catching up to the two men, and only managed to keep them in sight at all by hanging onto the railing, sliding himself along walls that were crawling with a chilly tingly pressure. The pressure grew worse and worse, the air of the stairwell swimming with a tingling cold-fire as Raed reached Floor 78. He was afraid that floor's fire-door might melt as he ran by it.

But he *had* to be passing the floors Flight 175 had actually crashed into—and the fact that the fire hadn't yet spread into the stairwell suggested it couldn't be too long after the crash. He might have as much as fifty minutes to get down and out.

He'd been told he'd come to no harm. Did that mean the projection team intended to extract him from the building before it collapsed? Raed had been in danger from the hail of burning shrapnel during the last ghosting, and his team seemed to expect him to rescue himself . . . *It's up to you what you do back in the past,* the psychologist told him.

Perhaps it was up to Raed to find a way out before the forces in this world crushed him.

The landing of Floor 70 had working lights, and so did the stairs below it. A brighter passage and clearer air helped Raed move right down behind the two men he was following, close enough to hear their conversation as he looked for an opportunity to pass them. The injured man was Garth, and he kept thanking Peter for pulling him to safety after the explosion. How long ago, Raed wanted to know, wishing the men

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would walk single file instead of one gripping the other. Peter kept insisting he'd done nothing special, switching back to his worries about coworkers who'd headed up to the roof instead of trying to get below the fire.

"Your coworkers are lost," Raed snapped in frustration, "and you'll be lost too, if you don't move faster!" These men were too calm—he *had* to get past them. At the next landing, he tried to shove himself between them—

HORROR-HURT-DESPERATION-CONFUSION

Raed crumpled to the floor, unable to withstand the tremendous emotional discharge. Peter and Garth weren't calm at all! They were barely keeping their fear in check. What had they seen before entering this stairwell?

By the time he got back to his feet and caught up to them, Raed saw that more people were blocking the stairwell below Peter and Garth. There was some kind of pile-up on the next landing down, a crowd gathered round a burn victim. The delay was far more frightening for Raed than for the people surrounding him—because he *knew* the building was going to collapse soon. Was this projection meant as punishment for his foreknowledge of the Flight 175 crash?

The Muslim psychologist back in 2033 suggested it was up to Raed whether the projection was punishment or—what?

What was he supposed to *do* here?

He passed more burn victims outside the door to Floor 67; men with most of their clothes burned away, their skin turned gray or even black, patches of flesh peeling from their limbs. The people staying to look after them had torn off shirts to make tourniquets. Others were cloaking the shivering gray figures in suit jackets. The next landing held another group huddled about badly injured people, and so did the next, and the *next*, forcing Garth, then Peter, and then Raed to file slowly past. Only Raed knew those groups were all doomed, but it wouldn't have made much of a difference if he could have communicated that knowledge, at least not to the burn victims—they didn't look as though they'd live long enough to make it to a hospital.

It was the people staying behind to console them—it was all the comforters that bothered Raed. There was so many of them! Why didn't some of them just head down to safety?

Because they weren't aware of the imminent collapse, as Raed was.

"Come *on*, move *on!*" he growled at Garth and Peter. Winding down through the suffering was taking too long, leaving too much time for Raed to wonder what all this was for. Surely there was more to his rehab than sharing in the harrowing experiences of 9/11 victims. There *had* to be more to it. But what more could he do in this past?

You really want to find out?

The psychologist's question nagged at him, and Raed tried to recall the theory they'd given him. Strong-weak two-way interactions . . . the past cannot be changed . . . because projection volunteers had *always* been part of the moments they time-traveled back to . . . so Raed had *always* been here—was here now—following down behind Peter, who had his arm wrapped round Garth's shoulder, guiding the injured man down.

But did—or would—Peter and Garth get out before the building fell?

No way for Raed to get past them now—there were too many people crowding the stairwell directly below the pair. Others were coming down behind Raed, sandwiching him in the stairwell, occasionally forcing him to bump into Peter or Garth—and to suffer another shock of PITY-ANXIETY-DREAD-DISTRESS, emotions that almost knocked him down. The discharges astounded him. *I can actually sense how these two men are feeling!* He remembered the black-and-white movie about

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the two angels in Berlin who could hear what people were saying, but whenever they listened to peoples' thoughts, the soundtrack reverted to German, leaving Raed only with a sense of the emotional-tone underlying thoughts. . . .

By the time they reached Floor 60, Raed was in a panic. Peter and Garth had to do a *lot* better than a floor a minute to get out in time—and to let Raed get out in time! This was a *lot* more nerve-wracking than the last projection.

But it seemed most of the injured had been already been passed, and below Floor 60, the stream of escapees began moving much faster. Peter and Garth slipped by slower people who were resting on the steps, and waving everyone coming down from above on past. Raed began to count off his own breaths, timing the pace between floors. He thought they navigated three flights in about a minute, timed it again and got the same result for the next three. They might just make it!

There was no panic in the stairwell, and no more injuries to pass until Floor 44, where a security guard and some others were trying to assist a man whose head was bleeding profusely. The people comforting the man looked up as Peter, Garth and Raed reached the floor; one of them asked Peter if he would send help from below. Peter agreed without slowing, guiding Garth on down the next flight with Raed right on their heels.

On Floor 40, they eased by a man in a foot cast being carried down by four coworkers who switched him between pairs at the landing, sharing the exhausting load. A compassionate act indeed. But would any of them make it out of the South Tower alive?

On Floor 33, there was an even more miraculous sight. People carrying a woman and her wheelchair down! The acts of selflessness Raed was witnessing inside the building he helped to destroy were wearing *him* down. He wanted to scream at everyone to drop their burdens and run—run so *he* could run too, down to the bottom and out onto the street before it was too late. Because it was impossible to believe he was *not* in the danger they were in, no matter how many assurances he'd been given that no projection volunteer had ever come to harm before. How could the force of the South Tower falling *not* harm him?

Garth and Peter finally got past the wheelchair crew, only to find the stairwell below the Floor 31 landing completely clogged with firefighters. At least a dozen of them were hoisting themselves up the steps in their heavy gear, blocking the route down—doomed men, the most doomed of all that Raed had seen . . . *because they were trying to climb up.*

As people bunched onto the landing—and Raed crushed himself into a corner to avoid unbearable contact-discharges—Peter moved over to the fire-door leading into the floor itself, and opened it.

"Let's try for the elevators," he said to Garth.

And Raed didn't hesitate, knowing there was no time to lose waiting on this landing. He followed the pair through the door, which closed behind him. Moments later he stood close behind Peter as the man tried the elevator buttons.

"Not working."

Try another stairwell, Raed prayed, realizing he was now trapped on this floor—invisible or not, he couldn't walk back out through a steel door or wall.

"Hey, there's some phones in here," Garth said, peering into a room off the hall they were in. "I want to call home."

No!

But both men were stepping through into the room, and the door was almost closed. . . .

Raed dove through just as it shut, afraid of getting stranded in the hall if there was another way out of that room. Sure enough, a door in the opposite wall of the conference room they'd entered had a stairwell exit-sign above it.

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Peter and Garth sat on the edge of the room's long central table, dialing up loved ones on the phones.

"No time! There's *no time*," Raed shouted at them, "we've got *thirty* more floors to go!"

It was no use. Raed stood close enough to the receiver Peter was holding to hear the anxious tones of the man's wife—but Peter couldn't hear Raed screaming right in his ear. "Put the phone down and go! *Please* go!" He pounded a fist on the phone-unit sitting on the table, trying to hang the damn thing up, when Peter suddenly hung up himself. But then the man began dialing *another* number, telling Garth he was calling in the EMS request he'd promised for the injured man up on Floor 44.

Peter was on hold with EMS for several minutes that had Raed howling around the conference room, both hands wrapped around the ripcord on his belt that was supposed to instantly return him to the projection-cage, eyes focused on the ceiling that might come down at any second. . . .

If Raed ripcorded back now, he'd be out of the program, his fear would have won and he'd live out the next fifty years in Lew Cell #1, knowing he'd been unable to face what these two men had faced.

But they had no idea what was about to happen!

Finally Peter got through, made his EMS request, and got off the phone. Raed ran to the door with the stairwell sign as the two men started toward it, opened it, then stepped through, leaving Raed just enough room to follow. The stairwell beyond was empty, and the only thing that slowed them as they hurried down was a pipe that spontaneously burst from the wall. A sign the collapse was about to happen? How many seconds left?

Water from other exploded pipes and from sprinkler-systems on the higher floors seemed to be collecting in this stairwell, making it difficult once more for Raed to keep up to Peter and Garth. . . .

And then, before he knew it, all three of them were at the bottom, hurrying through an underground plaza toward an outside street. A cop halted the two men before they crossed the street, warning about debris dropping from above—

Raed just ran for it, leaving his companions for the first time since Floor 82.

He'd made it!

He put a block between himself and the South Tower before looking back to see if it was coming down yet. Smoke billowed out of the hole two-thirds of the way up. He had to get farther.

But Garth and Peter were running over, and for some reason Raed waited for them, watching the sky overhead just to be sure. When they caught up to him, Raed began following the pair again, curious to know whether they'd get far enough away to survive. More than curious: he *wanted* them to survive. He *cared* about these two American strangers, having shared in their ordeal and overheard their exchange of friendship. Was that the whole point of this projection? Or was there more to it, something he'd failed to do?

As the two men continued north along the rubble-strewn blocks, Raed felt a weird echo of the relief they were professing to each other. Garth again thanked Peter for saving his life, Peter again dismissed the notion. Little did he know! A clock on a big electronic billboard read *9:59 AM*. They'd made it down and out with only seconds to spare. Were they far enough away?

Garth stopped in front of a church, and asked his friend whether he wanted to go in. Peter nodded, then they both turned for one last look at the South Tower. It was visibly shuddering.

"That building could come down," Raed heard Garth say.

Peter dismissed that notion too. "It's a steel structure, there's no way—"

The building began to implode before

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their eyes.

Peter and Garth dashed around the side of the church for protection, and Raed did too. After a few minutes, the rumbling stopped, but the dust and debris kept coming, thicker and heavier, churning into the all-enveloping gloom. The two men beside him closed their eyes against the dust-fall, and for a few seconds, Raed did too. *All those people*, he thought, his mind's eye recalling faces seen high in the stairwell, people he was sure didn't make it out. He may have been *aware* of the outcome of Nazir and Sayf's attack back when he was twenty-four, but only now did Raed *understand* that outcome. Only now did he appreciate the sort of selfless, courageous people who'd ended up caught in the aftermath of his cousins' actions. . . . Nazir had told Raed they'd be bringing down America along with those two buildings. But all they'd brought down was—

Well, Americans.

All those people, he thought again, horrified by the outcome for the first time in his life. Then he heard Peter say it too: "All those people," the big man croaked, shaking his head. Beside him Garth was weeping.

But they, at least, had lived. Peter and Garth had lived! And as the two men began to swirl away, Raed had just enough time to regret parting company with them before their faces vanished into the tunnel of history, and he found himself back—

In 2033, back in the present.

Back in his cage, blinking at the bars, and thinking of Peter and Garth. Did they still live, in the present?

"Anyone see you that time, Raed?"

It was the veiled psychologist, entering the cage again.

"No," he answered. "I mean—I don't know." Some of the people comforting the burn victims in the stairwell had looked up as he'd passed by. Raed had *thought* they were looking at him at first, before realizing they'd been looking at Peter or Garth or at someone else behind Raed. . . . Perhaps the same was true of that woman he'd seen in the previous projection, the one in the NYU sweatshirt with the red ribbon—perhaps she'd also been looking at someone passing behind Raed. Who could say?

He was still too horrified by his latest experience of 9/11 to think clearly.

But a feeling of horror wasn't enough. Raed saw that in the eyes of the psychologist standing below him, tapping away at her slate. He had not faced whatever he must face, had not done whatever he must do. What *could* he do, without changing the past?

"That was your longest projection so far," the psychologist told him, "almost an hour. So we've only time for a few more. They'll be short and to the point. And for the next one, Raed," she said, "remember what your lawyers told you."

"Just send me," he groaned.

But she stayed for another second or two, holding Raed's eyes, her own wide eyes filled with—foreboding? After she slid out between the yellow bars, Raed closed his eyes and clenched his teeth, preparing to ghost once again back to 9/11. So many projections to the same target-time! He thought of the two firemen at Ground Zero who'd taken turns climbing into the crow's nest of their pumper truck, returning to the fire time and again, refusing to give up even though hope was already gone. If they'd been able to face it over and over, well then, so could Raed.

But when he opened his eyes, he was surprised to find that—

He was back in a stairwell in the South Tower, standing on the landing of Floor 54, no one in sight. And right in front of him a zipper-rip was forming in the outer wall.

The whole stairwell seemed to pitch. Raed lurched for a railing of the flight leading down, barely able to keep his

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feet. What had the lawyers told him? Emotional harm was the only real danger during a projection—and if he used the ripcord before the cage operators brought him back, he'd be automatically disqualified from the program. . . .

Raed scrambled onto the flight leading below only to stop short halfway down, seeing some people appear at the bottom climbing up. Firemen! The same doomed men he'd seen around Floor 30 during his last ghosting. They were all panting, far more exhausted now.

And even if he could get down past them, he would never make it out in time, not this time. *Short and to the point,* the psychologist had promised.

The building rocked again, and Raed sprawled onto the steps, one hand gripping the railing to keep him from sliding into the firemen below, who were all hanging from the same railing and staring at each other, clearly wondering whether they should continue.

"Go down!" Raed wailed at them, pulling himself back upright.

And the firemen reacted, but not to Raed's yell—someone trapped a few floors higher was screaming for help. En masse they began to climb, aware of the danger of collapse but not of its imminent certainty.

Raed flattened himself against the stairwell wall, wrapping both arms around the railing—and then the firemen were crushing up *through* him. He could *feel* their huge souls, giant lionhearts swelling with FEAR-FURY-DEFIANCE-DETERMINATION. And during the endless seconds it took for them to climb by, Raed believed that *nothing* could kill such men. . . . After the last of them had passed, Raed slumped to the stairs, and lay there in a heap as the building rocked and rippled. The firemen were forced to stop just above him, all of them bracing themselves against the walls.

"Feel that just now?" gasped a man two steps above Raed.

Another nodded. "Something's telling me we're not gonna get out of here."

Had they sensed Raed's thoughts as they pushed by him? But no, individual thoughts could *not* be exchanged. Biomass could *only* produce "strong-weak" interactions: strong from these firemen onto him, too weak from him onto them to change their minds about anything.

And any further words the firemen above him might have said were abruptly drowned out by loud *snappings* and *splittings* that sounded to Raed like the fabric of the Universe tearing. The sounds snowballed into a terrific roaring, and Raed moved one hand off the vibrating railing onto his belt, fingered the ripcord, and looked up in anticipation—to his astonishment, some civilians who had made it down from the landing above were squeezing between the firemen. Then the stairwell walls seemed to give out, the people above clutched onto their would-be rescuers, Raed instinctively grabbed the railing with both hands, and God in Heaven dropped the world of 9/11 down on top of him, using the building Raed helped bring down to smite him once and for all—

A sharp smell roused him. Raed opened his eyes, unsure of where he was. Two figures swam into view: the burqa-veiled psychologist and the burly male medic, who was holding smelling salts.

Raed took in a painful breath, raised both hands to his chest, and checked for broken ribs.

"It's just sympathetic pain," the psychologist assured him, "all in your mind."

"You're okay," the medic agreed. "It's just the shock of being blown out of the fold."

"Why—" Raed broke off, sucked in air, still psychologically winded. "Wasn't I crushed? Gravity of the past . . . pulled everything down on us—on me."

The medic pointed to the inward-pointing cones studding the cage's arc-

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ing bars. "The particles they focus on you only open a *transient* fold. Any strong force exerted on the exterior—the force of a wall falling on you, a bullet fired at you—and the fold's sphere spontaneously pops, blowing you right back here. Bit of a shock," he repeated, "but you get used to it."

"You've faced. . . ." Raed wasn't sure what to call it.

"A 'mortal force' in the past?" The medic rolled up a sleeve, revealing a tattoo of the Statue of Liberty on one big bicep. "I was born in France," he said, "so I ghosted back to the Revolution, and got hit by a cannonball fired into a crowd outside the Bastille—I was standing too close to some of my ancestors." The big man folded his arms, frowned up at Raed. "Gotta tell you, facing death during a ghosting's not the hard part. It's not easy—but it's not the hard part."

"What," Raed wheezed back at him, "is the hard part?"

The medic looked over the psychologist's shoulder, and read something on the slate she was accessing again. "I believe you already know," he said, then nodded at Raed and left the cage.

Raed met the psychologist's wary eyes.

"Can you?" she asked him, a hint of pleading in her voice. Had she expected him to ripcord out before the South Tower collapsed? Had she hoped he'd stick it out with those firemen?

The thought that the psychologist held out a faint hope for him gave Raed a little strength. "I think . . . I can," he breathed, then began breathing easier.

After all, he knew now she'd been telling the truth. He *couldn't* come to harm. And after she exited the cage, Raed watched the psychologist and the others outside the bars begin to slide away, knowing the next projection couldn't get any worse, it could only get—

More strange.

Raed dropped to the floor of an elevator with its double-doors partially open. Beyond the gap in the doors a debris-littered lobby kept rising, then plunging, then rising again, as though the elevator was a yo-yo on a string about to snap. The steel walls around him were visibly vibrating, so he knew he didn't have much time. But he waited until the lobby outside fell from above his shoulders to a foot below the level of the elevator—

Raed threw himself out, landing flat on his chest on the cluttered lobby carpeting. A sign fallen from a shuddering wall told him this was Floor 104 of the South Tower. And there was a man propped against a smoldering reception desk nearby, his legs trapped under a huge twist of black metal that had stabbed down through the ceiling.

The trapped man wasn't alone.

Raed got to his feet, staggered closer, and stared at a woman kneeling beside the trapped man, her arm round his shoulder. She stared back at Raed, following him with her eyes.

"You *can't* see me," he insisted, and then fled from the pair, down a hall, and around a corner, not wanting to be seen by a victim about to meet her end. Not wanting to sit idly by as two more people met their doom, unable to do a thing about them or himself.

Not understanding what he was *supposed* to do here!

Ceiling panels crashed down in a hall he turned into, and an electrical panel exploded. Raed was driven back, his time probably almost up again. *Short and to the point.*

The point being to meet *more* of the people he'd help trap in this tower? *I* didn't *trap them, I* wasn't *on that plane. It was Nazir, Sayf, and their comrades!* But no matter how he tried to rationalize, how he tried to escape, Raed was blocked at every turn. There was just no way out. Corridors came down in a rain of rubble, passageways filled with a tingling pressure before bursting into flame, and doorway after

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doorway was barricaded by debris. All the rooms within rooms closed off to him now, all his mental defenses collapsing, forcing him back to. . . .

The central lobby and the elevators, where he hated to go but had to, and—in the end—wanted to, so he wouldn't have to face the end alone. As he stumbled into the lobby, Raed saw the trapped man now had two companions consoling him instead of one, both comforters wearing red ribbons on their collars but neither looking at Raed. Their eyes were squeezed tightly shut, knowing the collapse was upon them, hearing the roar and hugging the arms of the trapped man, one on either side, their faces agonized.

Yet the man propped between them seemed unaware of his two steadfast friends, his hands clasped together in prayer, face somehow calmer, eyes turned up toward his own version of Heaven. *We do this to Americans because they are godless,* Nazir had told Raed repeatedly.

And that was not true.

And feeling horror for this trapped trio was not enough.

Raed threw himself down on the shuddering floor before them. He knew what the hard part was now. "I don't have the strength," was all he had time to say before the world descended on them all again—

Sharp reviving odors.

Opening his eyes, squinting at yellow bars, then down at the big medic, and the small Muslim psychologist.

"Was seen—again," Raed managed to say when he'd caught his breath. "Were two of them. Two . . . shouldn't have been there."

"What do you mean?" The psychologist was tapping it all into her slate.

"Both wearing ribbons," Raed said, less winded this time. "Pinned to sweatshirts," he went on, "like the other one who saw me—when I turned up that side street."

She surprised him by replying, "You've gotten a long way into our program tonight Raed, and you're nearly there."

"There?"

"Understand—the program's spiraling you toward the core-event you were convicted of being an accomplice to. Time to take you in for a close-up."

He nodded. The hard part still remained. "Go ahead," he said, no longer caring. . . . There were no rooms left to hide himself inside anyway. Raed's own core had been drawn out now, and he was ready for anything, ready for the truth.

Again the psychologist hesitated before leaving, and again her lingering gaze gave him strength. *She wants me to see it through.*

Raed realized he wanted to see it through, too.

Seconds later the cage-bars began to blur, then bend away, and before he knew it he was—

Back in the South Tower, and for the first time, he'd arrived *before* it was hit. . . . The floor around him was filled with people, a dozen desks visible in an open area near some tall windows, a few of the desks still occupied by people making phone-calls, although most looked upset. Most others had left their desks and were standing at the windows, looking out at the North Tower, which had a smoking hole a number of floors higher up its side.

What floor was he on in this building? Raed turned and hurried around to the elevators, darting in and out of groups of people, and in the central lobby discovered he was on Floor 78.

The point-of-impact for the South Tower.

Raed kept right on running through the floor, around to the tower's opposite outer wall. Finding another open area past a row of offices, he peered out through some windows facing south. A gleaming speck was just visible against

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the blue sky in the southeast, slowly arcing around to get into position.

Raed had often wondered about Nazir and Sayf's last moment in that cockpit. In the early years, he'd even tried to picture it: opening their shirts and exposing their hearts to God, praying for entrance to Heaven. Madmen, and Raed had sensed it even then. But he'd been a little mad himself, in that period. . . . And now that he was in a position to glimpse the expression on their faces as they plunged into the side of this building, Raed found he had no interest in glimpsing any such thing. He turned his back to the windows.

Four of the dozen desks arrayed before him had knots of people standing around them. And sprinkled in among the business attire worn by most of those people—none of them currently looking out the windows to the south—there were a handful of standouts in casual clothes, sweats, even one in an all-blue jumpsuit. All the casual-dressed people had their hands on the shoulders or backs of one or another of the victims-to-be.

Raed moved over to the nearest occupied desk, where a young blond-haired man in a crisp mauve shirt and black tie sat facing the outer windows, too busy talking on the phone to notice the speck growing in the sky beyond the windows. Standing directly behind this young businessman was another older blond-haired man, in his mid-forties perhaps, approaching middle-age, yet dressed in silvery track pants and a Columbia University pullover. He had both hands on the shoulders of the desk's occupant and was crouched over him, head bent low, eyes closed and concentrating, to all appearances eavesdropping on the seated man's phone call.

Neither the seated man nor anyone else in the area seemed to take any notice of this peculiar eavesdropper.

Except for Raed.

"Who are you?" he asked the man in silver track pants.

The man frowned up at Raed, his concentration broken. Raed immediately saw that the eavesdropper and the businessman below him might have been twins, but for the ten-year age difference between them. And now the red ribbon pinned to the eavesdropper's collar was plainly visible . . . Below him, the seated man continued reassuring whoever he was talking to on the phone that he was all right, that it was the other tower that was hit—but his eyes were finally widening, focusing on something behind Raed, beyond the windows. The eavesdropper bowed over the seated man again, concentrating harder, tightening his grip on his younger twin's shoulders.

Out of the corner of his eye, Raed caught other people reacting to something in the sky beyond the south windows. And now, somehow, there were twice as many people in sweats and casual clothes in the open area—though Raed had seen no one enter the area. All the newcomers had their heads bowed, holding tightly to some shocked-looking businessman or woman.

"Who *are* all of you?" Raed yelled across the open space.

He got no answer. The casual-dressers were too focused on the task at hand: remaining in physical contact with people who were beginning to scramble away in disbelief—

A loud clattering drew Raed's eyes back to the desk he was standing in front of.

"Oh God, *oh my God.*" The young blond businessman had dropped the phone receiver and was on his feet, gaping at the windows behind Raed. A woman's voice squeaked out of the receiver inches from Raed's hip: "Steve? You still there, Steve?"

The older man in silver track pants clung onto Steve, his face pained—

Then everyone was breaking free from their casually-dressed companions and fleeing, falling over chairs and furniture in desperate attempts to escape.

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And all the ribbon-wearing clingers left behind turned toward Raed.

"Why did you bring me here?" he cried as he backed right up against the windows, wanting this to be over quickly. A shadow fell across the area of desks—

Revived again, safely back in his cage in 2033.

Raed focused blearily past the bars and across the main projection arena, where a hundred other volunteers hung suspended in cages too, most of them mere image-people, half here, half there, still currently ghosting somewhere. In some of the closer cages, volunteers appeared to be crouched over something in the past, or clutching onto someone. Those in the closest cages seemed to be in some kind of pain.

But a number of volunteers were no longer glowing images. Their projections had just ended, just like Raed's. In one or two cages, he could see people being revived with smelling salts. . . .

In his own cage, the Muslim psychologist was again consulting with the big medic, both standing just below him. Raed waited until the medic slipped back out before he summoned to will to say to the psychologist, "I need to ask something."

"Ask."

He gestured toward the cages filling the main arena. "Those people are all ghosting back to 9/11, aren't they? They've been accompanying me. . . ."

"They have their own business in that target-time," she told him.

Tackling what I've been avoiding, Raed thought. The hard part.

"But yes," the psychologist went on, "they are accompanying you, in a way—they're projecting through folds oriented identically to your own." Behind the burqa-veil, the woman's eyes seemed disappointed. "Is that your question?"

He would not disappoint her. He said, "They're the group of 'interested citizens,' yes? The ones who petitioned to get me into this program."

She nodded. "Is that your question?"

"Who are they?" Raed asked. That was *the* question.

"The grown children of your victims, mostly," she told him. "Plus a few victims' nieces, nephews, friends, one or two of the surviving spouses."

Raed swallowed, a soft clicking deep in his throat. "And you?"

"Yes," she answered without hesitation, her liquid-black eyes swallowing his question. "I'm also the child of one of your victims." She adjusted the folds of her burqa to show him the red ribbon she was wearing. The same ribbons worn by the out-of-place clingers and companions in the past—the people in the cages beyond the Plexiglas.

Raed bowed his head. If the woman below him *was* his daughter, then Haifa, his wife, was surely another of Raed's victims. And if the woman below him *was* his daughter, surely it was no surprise she'd become a psychologist—not with a father like Raed to try to comprehend.

She said to him: "I was one of those curious to see if you were capable of making it through this program." A beeping drew her eyes to her slate. She turned, nodded to the projection operators at their consoles, and glanced up at Raed again. "Looks like we have time for just one more."

"Just one more," he agreed, even though he felt wearier than he'd ever imagined he could feel—weary down in his soul.

But there was one more place left to face, wasn't there? Raed watched the psychologist step out through the bars, then watched the world of 2033 slide away as the cage tunneled him back to—

That oh-so-familiar tubular space. He was back where his night of projection began, back in a seat on board a large passenger jet.

This jet, however, was airborne.

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Flight 175, Boston to Los Angeles. Raed was sitting in a window-seat about halfway up the plane. The oval portal beside him offered a good view of the Atlantic beyond the wing, and the Eastern seaboard. The plane was already well off its flight path, well on its way to its doomed target. But the familiar Manhattan skyline was not in sight yet; there was still a little time left.

Raed shifted out to the empty aisle seat, saw that the back half of the plane behind him was crammed with passengers. There were even people crouching in the aisle. Directly across the aisle, in the same row as Raed, a sturdy-looking man in his late thirties was dialing someone on a cell phone. After a few seconds the man began to speak. Raed instinctively drew back, then forced himself to listen: ". . . flight's been hijacked," the man was saying. "I'll try to call again, but don't know if there'll be time."

You must be Tom, Raed thought, recognizing the voice and recalling a bright kitchen with an answering machine in a warm Rhode Island home.

"Whatever happens, Angie, know that I love you," Tom went on, maintaining his unearthly calm. "That I'm thinking of you now, and the kids too. . . ." He let out a breath. "They'll be fine with you as their mom," he said. "So don't let them be sad for too long."

Raed stared across the aisle, humbled by Tom's ability to pass beyond denial of his dire situation into an acceptance of it. This man was neither hysterical nor paralyzed by terror—he was just terribly lonely.

"I'll always be with the three of you. And Angie," Tom finished, "in my heart I know we'll meet again." He shut off his phone, and turned to stare out the window.

That's when Raed caught a glimpse of someone seated on the far side of Tom, tucked up against him. Raed pulled himself to his feet, stepped into the aisle, and saw a sixty-something woman with her hands wrapped round Tom's arm, her head on his shoulder, her face drawn tight, concentrating.

She wasn't wearing a seatbelt because she didn't need one, of course.

Raed wanted to ask the woman her name, but sensed it wouldn't be appropriate. Besides, he knew who she had to be: "Angie"—Angela or Angelica—Tom's spouse. An old woman now, yet still strong enough to ghost back to her lost husband's side, strong enough to withstand the discharge of his dread long enough to add a little of her own calm to his. Angie was comforting Tom on the way to that greater comfort the man clearly had faith in.

The plane rolled, awkwardly changing direction, tossing Raed off balance. Through the windows of the forward seats he spotted distant skyscrapers, including the towers of the World Trade Center. Up in the cockpit his cousins and their pilot friends were beginning the approach to the South Tower, intent on bringing it down. And because Raed had known their intentions before his cousins and their comrades ever boarded this plane, he was just as responsible as they were. He could no longer deny it, now that he was actually on board with them. He'd *always* been on board with them, in some sense or other. . . .

So the thought of walking up to the cockpit door and eavesdropping on Nazir and Sayf's final words held no interest for Raed. His cousins' hold over him disintegrated long ago, in the awful period after the Twin Towers came down.

Raed turned his back to the cockpit, and began to walk down the aisle, looking over the people filling the rear of the plane—his cousins' victims, *his* victims too. He knew there'd only been sixty-five passengers on Flight 175, but he could see closer to a hundred crowded into the rear rows. Before him a sad and beautiful truth was playing out. . . . The plane banked again and Raed reeled on his feet, but not because of the deficiencies of the pilot. What he was seeing

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was almost too overpowering to witness.

The back of the plane was packed with lonely people, many of them being comforted by their own ghost-children—mostly full-grown forty-somethings now, adults strong enough to come back to this unthinkable moment, to tackle the hard part and take on the two-way interaction "biomass" unleashed: strong emotions flooding from the passengers into these ghost-descendants.

And weak emotions seeping from the ghosts back into their long-lost loved ones.

Whatever weak effect we have on the past, the researcher Francis told Raed, *it was made the first time around, if you get my meaning. So nothing can be changed!*

Cause and effect aside, every row Raed passed held an anguished-looking adult in track pants or jumpsuit, a red ribbon pinned to their collar. The ghosts were squeezed in behind the seats of some passengers, leaning over headrests, arms draped down around the shoulders of a mother, or an aunt, or a family friend they'd come back to comfort. A few were even kneeling in the aisle, their heads tucked onto the laps of passengers. All these agonizing visitors were soaking up the frenzied emotions of the passengers, while oozing an ounce of serenity back the other way, an ounce of certainty that their loved ones were with them, in spirit.

It was all they *could* do. Raed understood that now, and he understood what the projection-team was putting him through. He saw the method underlying their rehab program, ghosting him back to see things that should help him know what to do, like those two firemen taking turns in the crow's nest of their pumper truck, falling out exhausted, then climbing back in again to help douse the raging fires.

That's just what Raed was witnessing in the rear of Flight 175, as some ghost-comforters overcome with emotion simply vanished, others immediately appearing to take their place. The volunteers from his own time were projecting in, in wave after wave, taking turns taking on the pain of relatives and friends in their moment of greatest need.

The plane dropped lower, and a cry rose up from several passengers on Raed's left. Through the oval windows he saw the smoke-trail from the North Tower, both buildings drawing inexorably closer.

Time to face the hard part himself.

In the second-to-last row, a woman was curled up with a tiny, tired-looking child, a girl the age of the Basma he'd lost. A middle-aged man in coveralls stood behind the woman's seat, his head bowed, his arms draped down over the woman's shoulders, while her own arm was wrapped tightly round the shoulders of the child in the aisle seat.

Raed lowered himself to his knees, falling into a prayer-position in the aisle beside the child, a victim of the pitiless madness of Raed's own youth. But pitying her now, he placed his arm across her, received the awesome discharge of her emotions, concentrated, and tried hard to push his own feelings and his fatigue back onto her: FORGIVE ME-FIND PEACE IN YOUR MOTHER'S ARMS-ADD MY WEARINESS TO YOURS. . . . The child's drooping eyes finally closed, Raed *felt* her fall unconscious as the plane accelerated down, saw some of the fear ease from her face in the last second of his embrace—

END OF FIRST
DEEP-PROJECTION CASE

Many more cases and depositions were presented to the World Court over the course of the hearings on deep-projection technology. Some were further examples of New Spiritualist experiments, like the program designed for the inmate Raed. These positive-result cases sparked far greater interest among

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the worldwide audience following the hearings than the overstated cases claiming negative consequences. So by end of the hearings the court made its controversial decision, lifting the ban on deep-projection "for limited use"—such use to be governed by a duly-appointed body that would oversee and approve projection programs.

I, Francis Drummond, am the head of that governing body.

The Hague hearings dramatically boosted the number of New Spiritualist volunteers, as it became apparent to the public that emotions transcend time in some miraculous way, and in a *two-way* direction. . . . From that day to this, our movement has spread into every culture, changing the nature of the mid-twenty-first century entirely. Projection arenas have been reopened or built anew in thousands of cities, and now hundreds of thousands of volunteers ghost back to the past, participating in programs designed to open their eyes to the universality of tragedy in cultures other than their own.

The result has been a wider recognition of our present as the precious, precarious climax to all our ancient pasts. After millennia of struggle and strife, back-breaking labor and bad luck, madness and sadness and small successes piled one atop the next, most societies are making that final leap up the ladder of progress toward a transcendent, tolerant civilization.

The goal of New Spiritualism is a reawakening to the truth of what has gone before us, what it has taken all of us to get here. And though the controversy rages on, today that goal is being achieved. Waves of volunteers are returning to comfort their own ancestors—or comfort mere strangers caught in the tragic forces of world history—as a way of thanking the generations whose sufferings helped bring about a world they feel fortunate to live in. The target-times these volunteers revisit are mostly old and familiar turning points of the past, key moments in the histories of many cultures. The oldest stories in the book, you might say, and each one defined by a truth that volunteers of all cultures report witnessing: down through the ages the greatest humanity is always to be found in the midst of tragedy and catastrophe, as the living cling to loved ones lost with hearts unbound. ■

Find enough clever things to say, and you're a prime minister. Write them down, and you're a Shakespeare.

—George Bernard Shaw

Life can be cruel, and it is ultimately tragic, but mostly it is wonderful, or would be if we'd allow it to be.

—Poul Anderson

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SCIENCE FACT

SEDIMENTOLOGY GONE WILD:

The Onion-Layer Approach to Time Travel

Richard A. Lovett, Ph.D.

If alien geologists ever visit the Earth, one of the most enduring legacies of humanity they might observe would be an odd dispersal of the metal lead throughout rock strata from the interval corresponding to human habitation. Since the appearance of the first primitive Bronze Age smelters, one of the hallmarks of civilization has been the release of this metal into the biosphere, raising its level by so many orders of magnitude that the amount in the average person's blood has increased by a factor of 500 to 1,000.

Lead fumes eventually find their way into sediments destined to be the rocks of the future. Just as some people see evidence for the impact of a "dinosaur killer" asteroid in a thin, worldwide dispersion of the rare element iridium, the "lead layer" could be an enduring, geological signature of the worst excess of an industrial civilization.

The science of studying rock layers is known as "sedimentology." It has helped bring into being the geological worldview, with its long time-horizons and slow processes, as mountains erode to mud that washes to the sea, only to be compressed into new rock that is thrust skyward again. These rocks have names drawn from the materials that formed them—sandstone, limestone, mudstone, etc.—plus other names designating the era in which they were created: Jurassic, Precambrian, Devonian, Pleistocene, Mississippian, and many more.

Sedimentology has lost glamour to newer fields of study such as plate tectonics (the theory of continental drift), but it is by no means a dead science. In any setting in which nature has given us an undisturbed, onionlike surface, sedimentology is the closest thing we have to a time machine, providing the means to peel back the layers one at a time to ferret out secrets locked away in history.

It's a time machine with applications far beyond conventional geology. But

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first, let's start with something traditional, beloved by science students of all ages. Let's start with fossils.

Bygone Bayous

I am standing in the middle of what was once a pond in an area that must have looked like the bayou country of Louisiana. Once, sluggish streams wandered toward a shallow lake, overflowing each spring as floods brought down silt, sand, and clay from distant hills.

But now it doesn't look at all like Louisiana. The slow dance of plate tectonics has shoved it a mile and a half into the air and replaced the hills with mountains that block off life-giving rains. A parched wind sucks moisture from my body and Sun bakes the few plants that eke out an existence from soil comprised mostly of multicolored rock. Cliffs rise above badland gullies that unfold like pleated skirts.

It's a surreal setting, straight from a science-fiction movie. But the location is earthly: southwestern Wyoming, a few miles from Rock Springs, a town that my guide—a geology professor named Charlie Love—jokingly tells me is most popularly viewed in travelers' rearview mirrors as they motor on, toward the tourist meccas of California or Yellowstone.

Love and I have come here to visit a turtle graveyard—a five-acre pond that dried up to leave only a five-inch-thick layer of siltstone and the remains of hundreds of prehistoric turtles. I stoop to touch a fragment whose mottled texture leaves no doubt it was once part of a shell. "These turtles were about as big as a pie pan," Love tells me, "maybe two or three inches thick. They lived here around 40 million years ago."

The statement itself is nothing odd; I'd long ago learned to think of our planet as a wedding cake of strata that could be used to date geological epochs and their fossils. But I'd always thought of the strata as large—typified by the hundreds of feet of once-Saharan sand now solidified into the red-rock country of Utah and Arizona, or the thickly layered basalt that buried big chunks of Oregon, Washington, Idaho, Nevada, and California under three miles of lava.[1]

Love's turtle pond is different. Whatever happened here occurred quickly, possibly in a single season. Did the turtles dig into the mud to hibernate for a spring that never came? Did something poison their pond? I didn't know. One year, there was a pond teeming with the reptiles; an eye-blink later there was nothing but caked mud entombing their bodies. The "turtle layer," as I came to think of it, represented a single event, not an epoch. It may have occurred an unimaginable number of years in the past, but it unfolded in a manner familiar to short-lived humans.

It was one of those moments that expands your view of an entire science. I'd long thought of geology as a time machine, but always before it had been set on rapid "fast-forward." Here, suddenly, I was face to face with the geological record of a human-scale event: a fossil disaster area. Love, ever the scientist, grins when I express this thought. "It was a disaster for the turtles," he corrects.

A few days later, I viewed more fossils at Fossil Butte National Monument. From the top of the butte, 8,000 feet above sea level, there's nothing to see but wrinkled hillsides of sagebrush and pastel rock, stretching to a mountain-etched horizon. Streamers of aspen mark the beds of intermittent streams, but the general impression is of a treeless land of unbounded, open space.

The fast-forward geological story is similar to Love's turtle graveyard. 50 mil-

[1] "Sedimentology" most often refers to the layers of sedimentary rocks (those formed from soils, mud, and the debris of earlier rocks), but volcanic deposits can show similar layers.

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lion years ago, the butte wasn't a hill, but the bottom of a shallow, 50-mile-long lake. Sediments accumulated like thin layers of fine pastry—1,000 or more per foot. Looking at them under a microscope, scientists realized that the layers looked a lot like the growth rings on trees, with alternating rapid growth (shale, created by silty spring runoff) and slow growth (limestone, from slow-accumulating, mud-free deposits later in the year). Nobody's counted them all, but rough estimates indicate the lake existed for about 2 million years—leaving a year-by-year record of its entire existence. It's even possible to track weather and climate patterns from the thicknesses of mud and lime in each year's deposits. And beneath the desert, pressed into these layers like autumn leaves in a child's book, vast schools of fossil fish swim frozen in an ocean of rock.

There are also crocodiles, fresh-water rays, and the oldest known bats, but the most dramatic finds have been the fish. They range from minnows to 15-foot behemoths, some so well preserved they show such delicate details as individual scales. Scientists can even identify the contents of their stomachs. Also of interest are "mass-mortality layers" where ancient ecological catastrophes that had nothing to do with humans caused fish to die by the millions. A single slab on display in the park museum holds 356 fish.

Sedimentology is an old science—dating back to when the first observers noted that the Earth exists in layers and that there might be value in keeping track of their order. Fossil Butte, however, reveals that we've barely scratched the surface of what the technique has to offer. Suppose that a method, akin, perhaps, to MRI or CAT scans, allowed us to scan cubic miles of rock with a resolution fine enough to track individual layers and catalog their fossils. Suppose that this could be combined with core samples that test the rock's mineral content, layer by layer. The result would be a 2-million-year ecological survey, conducted in a single step.[2]

Fossil Butte isn't the only place where geological processes have preserved finely textured layers. The same techniques could also be used on Mars or other geologically-active worlds. Even if there are no fossils, the ability to study rock layers, season-by-season on a large scale, might provide valuable clues to the planet's prehistory and the fate of its water, oxygen, or other vital resources.

In theory, such studies could be done today, with hand techniques, but they would require enormous, painstaking efforts, not only to keep track of individual layers with sufficient accuracy, but to do so across sampling plots large enough to produce statistically meaningful numbers of fossils. Furthermore, today's fossil-digging techniques are destructive—the pastry layers have to be scraped away to reveal what's in them, precluding later study with better techniques.

High-resolution scans of entire mountains are beyond the capabilities of modern technology.[3] But core sampling is a different matter, at least if you're looking for something small and uniformly enough dispersed that a borehole won't miss it. It too is a process by which innovative scientists can slow down the traditional "fast-forward" mode of sedimentology to track natural and not-so-natural processes on a year-by-year basis.

[2] Remote scanning would also have enormous applications to mineral exploration.

[3] Low-resolution scans can be done by seismology, using the deflection of shock waves from earthquakes or explosive charges to map boundaries between major rock layers. These methods do not even remotely approach the level of detail under discussion in this article, however.

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The remainder of this article will examine ways this can be done to examine everything from prehistoric air pollution to climate shifts that might have helped flash-freeze the woolly mammoths occasionally found in the Siberian arctic.

Digging for Dioxins

Let's return to the lead spewing from those Bronze Age smelters. They were probably nasty neighbors, but on a global scale, they produced a lot less lead[4] than the gasoline used in mid-twentieth century automobiles. Is it possible to find even these earliest traces of the "lead layer"—marking that crucial shift from stone tools to metal, and all that metal-using civilization implies?

The answer is a resounding "yes." Theoretically, scientists could trace these deposits via lake-bottom sediments—Fossil-Buttes-in-the-making.

We'll discuss such lakes in a moment. But researchers have an even better place to look—in snow layers of the ice caps of Greenland and Antarctica.[5] Extending backward for 400,000 years, these layers trap air pollutants and even air bubbles. To determine their age, scientists merely count the layers, calibrating their dates against deposits from known events such as volcanic eruptions. Such studies have not only identified the fallout of the first primitive smelters, but have shown the marked reduction in atmospheric lead from the much more recent phase-out of leaded gasoline.[6]

Scientists can also use ice cores to trace the environmental footprints of other human activities. Jihong Cole-Dai, a chemist from South Dakota State University, has examined sulfates and nitrates in parallel samples from Greenland and Antarctica. This allowed him to trace separate pollution histories for the northern and southern hemispheres—possible because these pollutants settle out of the air more quickly than prevailing wind patterns permit the atmosphere to mix across the equator.

Cole-Dai found that in Greenland, the sulfate level was relatively stable until the mid-1800s, when the Industrial Revolution produced the first massive use of coal. Then, concentrations shot up, doubling or tripling until the past few decades, when they appear to have reached a plateau. Nitrates showed a similar trend, but the surge was smaller, occurred later, and appears to have dropped off more substantially since its peak. In Antarctica, on the other hand, both nitrate and sulfate levels have remained stable, except for short-term variations from Southern Hemisphere volcanoes or wildfires.

These findings aren't particularly surprising, tracking nicely with the onset of coal burning, automobile use, and emissions controls in the more industrialized north. What is intriguing is the degree to which these histories appear in the ice—validating the use of trace chemicals in ice cores as a method of tracking the planet-wide growth (and, hopefully, environmental maturity) of an industrialized civilization.

Lakebed sediments offer similar opportunities. In one study, David Cleverly, an environmental scientist with the U.S. Environmental Protection Agency, mea-

[4] Bronze is made mostly of copper and tin; lead is a contaminant.

[5] Much of the research discussed in this section was presented at the 2001 spring meeting of the American Chemical Society, April 1–5 in San Diego, California.

[6] Other tests use carbon dioxide in air bubbles as a measure of CO_2 in the atmosphere, calibrating the results by comparison to air measurements made during the last 50 or so years. Such tests provide long-term data for researchers concerned about global climate change.

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sured dioxins, furans, and PCBs in a dozen lakebeds. Of particular interest were core samples from Lake Ozette in Washington State's Olympic National Park. The lake lies within three miles of the Pacific Ocean, increasing the chance that its sediments reflect global, rather than local, levels of air pollution.

Unlike ice cores or the rock at Fossil Butte, this mud apparently had no readily countable layers. Dating could still be done, however, with radioisotope methods, which showed that the cores spanned about 260 years, from the 1720s to the mid-1980s. Measuring dioxin contents to the picogram (10^{-12}) level, Cleverly and his associates were able to compute the rate at which dioxins were deposited into the lake's watershed.

They found trace amounts even in the earliest samples—presumably produced by forest fires and pre-industrial smelting operations. But from the 1930s until the 1950s, the rate of accumulation skyrocketed, increasing nearly 10-fold before beginning a steady decline—although it remained high by pre-twentieth century standards. Sediments from other lakes, Cleverly adds, behave similarly, increasing the researchers' confidence that what they are measuring is global pollution, not merely a local industry's. Similar trends were found for furans and PCBs.

Cleverly then turned to another source of samples, packaged meats dating back to 1907. Dioxins, furans, and PCBs can survive in such products for many years if unopened packages are properly stored—and Cleverly found what he needed with the help of curators at the Smithsonian Institute and the U.S. Army's Quartermaster Museum. These institutions supplied him with unopened C-rations from World War I, foods prepared for astronauts, plus a dozen other types of unopened meats.

Modern beef, pork, chicken, and milk show about one part per trillion of dioxins. The samples from World War I were contaminated at much lower levels, while dioxin levels peaked at about four parts per trillion in Vietnam-era samples—almost exactly the same pattern that Cleverly saw in the Lake Ozette sediments. Furan levels showed a similar rise, but PCBs skyrocketed much farther, hitting levels in the 1960s that were about 10 times higher than those found in current surveys, nicely tracking these compounds' introduction, use, and phase-out.

Turbulent Seas

Not all studies work out so nicely. Terry Wade, an environmental geochemist from Texas A&M University, attempted to track DDT, PAHs (polycyclic aromatic hydrocarbons), PCBs, and lead in nearshore ocean sediments from Galveston Bay, Tampa Bay, and the Mississippi River Delta.

After dating core samples by measuring radioisotopes from nuclear bomb tests and the atmospheric decay of radon, the researchers were able to trace, in general terms, the rise and decline of U.S. use of the four pollutants. But they had difficulties finding sample sites whose layers hadn't been scrambled by dredging. Another impact of industrial civilization, it appears, is that it *stirs* geological layers, blending sediments in ways that defy even the most advanced tools of sedimentology.[7] Sedimentologists attempting to trace the rise and fall of human (or alien) civilizations would do best to direct their efforts to locations remote from the cultures under investigation.

One thing is certain, however: Until someone invents a true time machine, environmental chemists will continue prodding into oceans, lakes, soils, ice, and museum displays in search of ever-finer measures of any environmental

[7] Animal burrows, such as those from bottom-dwelling worms, can have the same effect.

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contaminant that is chemically stable enough to leave lasting traces.

A Difficult Task

Doing such tests, however, isn't as easy as it sounds. Even the "polluted" Bronze Age ice layers are remarkably pristine by today's standards. When it comes to lead, researchers' hands, clothing, and equipment can carry more of the metal than the sample, making it far too easy to ruin a study before it's begun. Similar concerns apply to trace analyses of any ubiquitous environmental contaminant.

Such problems were first recognized three decades ago by Clair Patterson (1922-1995), the first geologist to accurately estimate the age of the Solar System by measuring lead isotopes in meteorites. (These isotopes are produced by the decay of radioactive uranium and thorium; their concentrations show how long it has been since a rock or meteorite was formed.)

After working out his geological clock, however, Patterson began to obtain anomalous results: Some earthly rocks appeared to be older than the Solar System. The problem turned out to be contamination of the samples by environmental lead of recent origin. Struggling with ways to eliminate this contamination led Patterson to invent a whole new array of ultra-clean sampling techniques, as well as alerting him to the degree of environmental lead contamination prevalent in the 1960s and '70s. (He spent his later years as a leading figure in the fight to reduce global lead pollution.)[8]

One of Patterson's former pupils, Ken Bruland (now a professor of ocean sciences at the University of California, Santa Cruz) recalls a story Patterson was fond of telling, about an attempt to measure lead in the alpine lakes of California's Sierra Nevada mountains.[9] One group of researchers rode helicopters to the mountains. "The helicopter burned leaded gasoline," says Bruland, "so they wafted lead all over the lake while they were trying to take samples. They came back with samples that were 1,000 times higher than normal." Patterson backpacked and snowshoed to collect his samples, using precautions that at the time appeared phenomenal. Needless to say, he got better data.

Another Patterson disciple, Russell Flegal, also of U-C, Santa Cruz, has continued to refine these ultra-careful techniques. "Everything is done in trace-metal-clean laboratories," he says, "with filtered air and metal-free surfaces and high-purity water." It's a type of research that might appeal to people with obsessive-compulsive personalities: Containers, for example, are cleaned with a process that takes three months to complete. But it has allowed the researchers to push laboratory lead contamination down to about 10 parts per trillion—low, but still not zero.

Much has been said about the need for scientists and explorers to be careful about microbiological contamination of whatever new worlds they might encounter. But if they're taking samples for trace chemical analysis, they'll also have to be extremely careful about their own field techniques, if they want to obtain meaningful data.

"Bungee Jumping Off the Roller Coaster"

The techniques of thin-layer sedimentology aren't limited to tracking trace pollutants or fossil fishes. They can also be used to study climate. To some ex-

[8] More about Patterson can be found in *Clean Hands: Clair Patterson's Crusade Against Environmental Lead Contamination,* by Cliff I. Davidson.

[9] I interviewed Bruland and others for the July 1999 issue of *Inside Laboratory Management.*

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tent this is possible with the Fossil Butte sediments, whose layers contain clues about each spring's runoff and the intervening dry seasons. A different type of data can be obtained from isotopic analysis of recent ocean-bed sediments (drawn, of course, from sufficiently undisturbed sites). These studies reveal the sources of the mud—allowing researchers to track, for example, the amount of dust from central China deposited each year in the Caribbean Sea—an indicator of global windiness.[10]

Ocean-bed cores can reveal an amazing array of details. Studies in the North Atlantic, for example, have found rocks that originated near Canada's Hudson Bay. The only way they could have gotten there was by melting out of icebergs at times when bergs were making their way into the ocean from that source—presumably as ice sheets were melting back into Canada at the end of an Ice Age. Sedimentology studies of such cores has helped flesh out the complex history of North American glaciation.

But the best climate records, at least from geologically recent times, come from the same type of ice cores used to study air pollutants. The thickness, crystalline structure, and isotope content of each layer of snow reveal a great deal about the weather in which it fell. Trapped dirt and sea salt are good indicators of windiness, while traces of methane in air bubbles reflect the rate at which swamp gas was being formed in the tropics, revealing the climate at locations far removed from the poles.

In part, the data support environmentalists' concerns about global warming, indicating that warm periods do indeed correlate with eras of high carbon dioxide (CO_2). But long-term climate changes turn out to be only part of the story. Other results are even more sobering. "Records in Greenland indicate that the climate we think of as normal is just about as stable and boring as it gets," says Richard B. Alley, a Penn State University glaciologist and author of a book called *The Two-Mile Time Machine*. "The past 100,000 years has been dominated by very fast, very large, and very widespread changes."[11]

What constitutes "very large"? Alley and his coworkers have found dozens of double-digit temperature swings, some as big as 15 to 18 degrees Fahrenheit. Most amazingly of all, these oscillations have taken place virtually overnight—often within the span of one to three years.

To put that in context, present concerns about global warming focus on shifts of one or two degrees over the course of several decades. That's enough to cause problems for coastal cities and to alter rainfall patterns worldwide, but the climate, as Alley puts it, remains recognizable. Not that such changes can't be important:[12] A cool-down of similar magnitude during the Middle Ages created an era in Europe

[10] Other climate data can be found by cataloging pollen grains that settled into bogs or lakebeds or the debris collected by generations of packrats dwelling in the same midden.

[11] Unless otherwise indicated, quotes from Alley and information about other studies described in this and the next section come from presentations at the 2001 annual meeting of the American Association for the Advancement of Science (AAAS), Feb. 15–20, in San Francisco.

[12] In "Summer's Lease," a fact article in the Dec. 2000 issue of *Analog*, J.R. Dunn argues from European, Chinese, and Anasazi history that such a slight warm-up might even be beneficial. The purpose of the present article isn't to dispute Dunn's conclusions, but to carry the discussion farther back into prehistory.

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now known as the "Little Ice Age." That, Alley points out, is when Hans Brinker skated the canals of Holland, glaciers advanced across Norwegian farmland, and the Vikings froze out of settlements in Greenland, whose once-lush pastures originally rendered the island's name descriptive, rather than a bad jest.

An overnight double-digit climate change is almost unimaginable (and a very suitable subject for science fiction). Because currently the Earth is relatively warm, the most likely change is downward. That might instantly convert Atlanta into Chicago, and Chicago into Winnipeg, Manitoba. Alley's studies also indicate that cold eras are windy. Florida newscasters would have to learn about both frostbite and wind-chill factors.

When abrupt climate shifts have occurred in the past, they appear to have affected large areas of the globe. The Caribbean ocean-bed sediments, for example, reveal dramatic increases in windiness that seem to have happened on the same cycle—and about as quickly—as the Greenland temperature changes. Such changes may be followed by additional fluctuations or by a millennium-long tenure at the new status quo. The worst case is a climate cycle that Alley compares to a toddler playing with a light switch;[13] *up-down, up-down, up-down*, in rapid-fire sequence. Big changes appear to occur only about once every 1,000 years, but Alley's graphs indicate that "small" ones (still substantially bigger than the ones that triggered and ended the Little Ice Age) might occur several times a century. Just about the time the residents of Atlanta get used to a sudden shift to a "Chicago" climate, they might find themselves teleported (metaphorically speaking) to Louisville, then back to Chicago, then to Minneapolis, etc., about once a generation until the jiggles settle down for a few centuries of quasi-stability.

If our planet's long, overall rhythm of alternating Ice Ages and warming is viewed as a roller coaster, Alley suggests, the short-term climate history, as far back as the ice cores can detect, has been like bungee jumping off the side of its moving cars. And the world we think of as "normal," he repeats, actually is anomalously stable.

Farewell Kilimanjaro

The polar ice caps aren't the only glaciers to contain climate-revealing strata. Similar studies can be done on mountain glaciers. The principle limitation is that even the largest of these doesn't contain old enough ice to reveal the wild instabilities found in the Arctic and Antarctic ice. What they do indicate is that in many parts of the world, mountain glaciers are rapidly becoming an endangered species.

Lonnie Thompson, a professor of geology from Ohio State University, has drawn core samples from glaciers in the high mountains of Tibet, finding that temperatures have gone up an average of 0.29° F per decade. The higher you go, he says, the greater the rate of warming. At the highest study site, 23,800 feet above sea level, the rise has been 0.63° F per decade.

These may seem like small changes, and in relatively cold Tibet, it will take a while for the glaciers to disappear. Farther south, however, the ice is much more precarious, and probably doomed within current lifetimes unless one of Alley's "bungee jumps" wildly shifts the climate in its favor.

One of Africa's leading tourist attractions is 19,340-foot Mt. Kilimanjaro, which boasts permanent icefields within 3 degrees' latitude of the equator. The mountain has lost one-third of its ice, however, since 1989, and 82 percent since 1912. Thompson predicts "a very real possibility" that the remainder will be gone by 2015. The same is happen-

[13] *The Two-Mile Time Machine*, p. 13.

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ing in the Peruvian Andes. Thompson mapped the retreat of one glacier from 1963 through 2000. During the first 15 years, it shrank by an average of 15 feet per year. By the last three years of the study, the rate of retreat had accelerated to nearly one-tenth of a mile per year—a 33-fold increase. Overall, Peru's stock of glaciers shrank from 970 square miles in 1993 to 720 square miles in 2001.

The demise of these glaciers is of more than aesthetic concern. The Peruvian icepack is a storehouse of water for a nation dependent on hydropower and needful of irrigation water. The only substitutes would appear to be dam-building, with all of its costs and environmental consequences, or a shift to fossil-fuel plants that would only add their own increment to worldwide warming. There's also a scientific loss. These glaciers once contained hundreds of years of strata carrying climate information directly related to equatorial, rather than polar, conditions. For example, they're a good source of data about the long-term pattern of El Niño and La Niña events (short-term fluctuations in the surface temperature of the Pacific Ocean, which can have dramatic impacts on climate throughout the world). As the glaciers melt, these records melt with them.

Crunchy Coyote Treats

In addition to "retreating" as their snouts melt up-valley, mountain glaciers melt from the top down, just like any other blanket of snow exposed to summer sun. As they do, they reveal—what else?—strata.

The largest ice field in the continental United States doesn't lie in the glacier-strewn peaks of the Pacific Northwest—although Washington and Oregon do boast a disproportionate amount of ice. It lies in Wyoming's Wind River Range, which scrapes snow from 13,000-foot skies in the wilderness southeast of the Grand Tetons.

A few years ago, after our visit to the turtle graveyard, geologist Love invited me to join him on a trek into these mountains. Scientists had long known, simply by comparing old photos with the present landscape, that the ice was rapidly thinning toward nothing; rock outcrops that were barely visible early in the twentieth century now stood hundreds of feet above the ice.[14]

But what Love urged me to see was a transient spectacle, in which the ice had melted down to a layer that was studded with locusts—the same species that in the nineteenth century swarmed across the plains in great clouds, eating any crop that lay in their path. The pioneers hated and feared them with a passion they normally reserved for prairie fires—basically for the same reason. But ultimately, the farms were the undoing of the locusts, which needed freedom to swarm across unbroken prairie. They've been extinct for years.

But here they were, littering the surface of a dying icefield—an entire strata of locusts, thawing in the summer sun. Even more interestingly, coyotes, ever the opportunists, had discovered the insect bodies and were wandering onto the ice to gorge on them—if I remember correctly, it was the discovery of extinct insect exoskeletons in coyote scat that initially led geologists to investigate the glacier.

Much as I'd have liked to, I was unable to join Love on his trek. But the image I never saw has lingered in my mind, merging the science of sedimentology with a vision of coyotes

[14] In an equally depressing observation, Thompson notes that his Peruvian glacier is rapidly receding toward the point where he drilled his first core in 1976. "I fully expect to be able to return in a dozen years or so and see the marks on the rock where our drill bit punched through the ice," he said in early 2001. If he's right, a 500-foot-thick layer of ice will have vanished in 35 years.

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dining on an extinct species.

From Mars to a Wicked CO_2 Irony

What are the implications for science fiction? One is that first-time visitors to alien worlds might do well to pay attention to these planets' ice caps, if any. The caps needn't be composed of water to carry useful climate data. The Martian ice caps, for example, are predominantly carbon dioxide, but they accrete, like snow, in annual layers, and there are indications that they're at least 10,000 feet thick.[15] That's room for a lot of climate data, once we learn to interpret it.

On Earth, the implications are even more readily apparent.

First, sedimentology can be used as a poor man's time machine to probe a staggering array of historical variables. All you need is a natural process that produces neat, orderly layers, a method of dating them, and the analytical tools to measure (or deduce) the variable of interest, whether it's a chemical contaminant or any other aspect of the environment in which each layer was formed. Astro-archeologists studying vanished alien civilizations might also do well to pry into ice layers, windblown soils, or any other stratified deposit dating from the right era. There's no telling what clues they might discover about the culture's daily life—and the causes of its demise.

But of greatest interest are the climate studies. What caused all of those wild gyrations, and will it happen again, in humanity's future?

Scientists are still speculating, but in the Northern Hemisphere, one critical factor may have been the interaction of North America's Ice Age glaciers with the Gulf Stream. The Gulf Stream, as anyone knows who's ever dipped a toe into the surprisingly warm waters off America's Eastern Seaboard, carries tropical water far into the North Atlantic. Thanks to it, Reykjavik, Iceland, has a winter climate that's warmer than New York City's. Alley likes to point to the Gulf Stream as the reason why Europeans can grow roses at latitudes where Canadians are dodging polar bears.

The Gulf Stream, however, needn't be a permanent feature of the North Atlantic. In today's climate, it is self-sustaining because the water, as it moves north, chills and eventually sinks—thereby drawing more warm southern water in its wake. But if the North Atlantic ever gets cold enough to freeze over, like the Arctic Ocean, the sinking would halt and the Gulf Stream would switch off. Iceland would earn its name, and polar bears might invade Europe.

The Gulf Stream doesn't freeze, partly because it's warm—and partly because it's too salty. But suppose that a cooling cycle overcomes this, allowing pack ice to form in the North Atlantic. Simultaneously, ice sheets creep south from Canada. They block the Great Lakes' normal outflow via the St. Lawrence River, creating huge temporary lakes that drain down the Mississippi. Later they retreat, and suddenly the St. Lawrence is unblocked. A huge slug of fresh water, perhaps as large as Lake Superior, blasts toward the ocean in a single, enormous flood.[16] Salinity drops, the ocean refreezes, and whoosh—temperatures

[15] I wrote about this in "The View from Space: Satellites Predict a Lot More than Weather," *Analog*, Feb. 2001, pp. 48-59.

[16] Such floods did indeed occur in the wake of the ice ages. The best known are those on the Columbia River of Washington, Oregon, and British Columbia, which during brief periods carried more water than all the world's present-day rivers, combined. See *Glacial lake Missoula and Its Humongous Floods*, by David Alt (one of the originators of the popular *Roadside Geology* series). When a warming cycle causes an ice dam to wash out, it fails completely, totally, and almost instantly.

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drop again as we start a new cycle: climate on a pendulum string.[17] (Sudden warmings have also occurred, but the mechanisms aren't as well understood—although it appears that they somehow, suddenly *restart* the Gulf Stream after it's been shut off.)

The good news is that this precise deep-freeze scenario can't happen today; for whatever reason, the last time the ice sheets retreated, they didn't manage to trigger a new advance. But that doesn't mean there's no way for them to return. The cause, ironically, could be global warming.

Remember, in the theory described above, it was a warming trend that sent that mammoth slug of fresh water down the St. Lawrence to trigger the next big temperature dip. There's no longer any ice waiting to pounce from that direction, but there *is* a huge amount in Greenland.

A slow global warming merely melts the ice cap and raises sea levels. A fast one rapidly dumps a lot of meltwater into the North Atlantic—perhaps enough to start the freeze-thaw cycle all over again.[18] Eventually, global warming may take over again and heat up the North Atlantic along with the rest of the world. But in the interim, life could be distinctly interesting in Europe and parts of North America. Alley compares the Earth's climate to the behavior of a drunk, sitting on a park bench. Left to his own devices, the drunk simply stays put (anomalously stable). But forced to move, he staggers. And continued emissions of CO_2 into the atmosphere may be prodding him into action.

Global warming isn't the only potential perturbation. Changes in plant life might have an even bigger effect, suggests Roger Pielke, a professor of climatology at Colorado State University.

Pielke is an atmospheric scientist who has modeled the effect of vegetation on global air circulation—specifically the impact of deforestation in tropical Asia on the path of the jet stream, which dictates much of the Northern Hemisphere's climate. The connecting link lies in the formation of thunderstorms. Without the rainforests, the land does not produce enough water vapor to fuel these storms, shifting them to more humid regions. This, in turn, deflects the jet stream in a manner roughly comparable to the El Niño events of the late 1990s.

El Niños come and go, as altered ocean temperatures near the equator shove the jet stream onto an unfamiliar course, then abate. Deforestation produces more lasting changes. Pielke's model shows several degrees of warming in western North America and strong cooling in Canada and Greenland.[19] The effect may already be under way; weather records in Thailand, Pielke says, indicate a reduction in rainfall at the tail end of the normal monsoon season—directly in line with the model's predictions.

Pielke also suggests that CO_2 build-up may have a quicker impact through its effect on vegetation than by its direct

[17] Another mechanism that creates the same effect (see *The Two-Mile Time Machine*, p. 158) is the sudden breakup of glaciers extending into Hudson Bay (remember those ocean-bed rocks rafted into the ocean on ice from this source?). The icebergs reach the North Atlantic, melt, reduce its surface salinity, and start a new cooling cycle, overnight.

[18] Alley says that some global warming models also produce a lot of rain falling into the North Atlantic, as well—another factor that might reduce its salinity.

[19] Some people will see this as poetic justice: the developed world's complicity in "mining" the tropical forests may rebound in altered weather patterns back home.

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impact on temperature (which, the greenhouse theory says, comes about from CO_2's ability to trap solar heat). The reason is that plants love CO_2. They grow faster, and in the process act like natural humidifiers. This smoothes out temperature extremes—cooling off days that would otherwise be hot and warming cold ones. It's an effect that could occur much more rapidly than overall global warming, and is one more way in which humanity might be incautiously kicking at Alley's sleeping drunk.

If we really knew what we were doing, we might be able to get all of the disparate effects to balance out into continued stability. There's clearly fodder for story scenarios involving heroic struggles to do just this. But faced with the record written in the ice cores, such scenarios look unlikely—at best the result of luck, rather than good planning. Most likely, the endeavor itself would merely set the drunk off onto an unexpected path.

The real message is that even though melting ice caps, climate shifts, and climbing sea levels have become stock features of near-future tales, science fiction has been far too conservative in its treatment of them. What we need are thoughtful assessments of how humanity might cope with a climate that started yo-yoing across 10-degree temperature swings, perhaps as frequently as once per generation. We know that plants and animals can survive this—otherwise they wouldn't have made it through the last series of oscillations. But what about civilization? How does it cope with a world in which climate zones can march 1,000 miles north or south during a single winter? It's time to think this out now, in fiction, before it becomes reality. ■

ANALOG
SCIENCE FICTION AND FACT

SALUTES
THE WINNERS OF THE
2001 NEBULA AWARDS

BEST NOVEL
The Quantum Rose
originally serialized in *Analog*
Catherine Asaro

BEST SHORT STORY
"The Cure for Everything"
Severna Park

BEST NOVELLA
"The Ultimate Earth"
from *Analog*, December 2000
Jack Williamson

BEST SCRIPT
Crouching Tiger, Hidden Dragon

BEST NOVELETTE
"Louise's Ghost"
Kelly Link

PRESIDENT'S AWARD
Betty Ballantine

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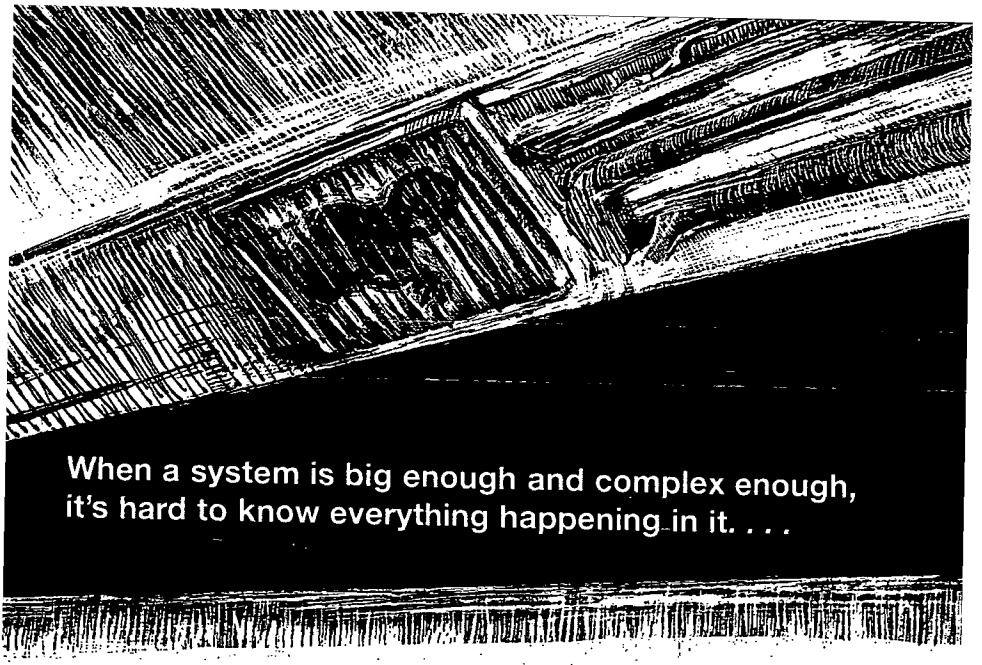

When a system is big enough and complex enough, it's hard to know everything happening in it. . . .

Far from the Emerald Isle

James Van Pelt

Illustration by Beryl Bush

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Dragging an equipment pack, Delaney crawled her way between *The Redeemer*'s slick inner wall and the rough-textured outer shell. Her tall, broad-shouldered rugby player's build wasn't the best choice for this errand. She envied the slight-figured Sierra who followed. Delaney's back scraped against the metal again, and she opened her mouth in exclamation, but bit the sound short. A dark shape moved in the claustrophobic darkness just beyond her headlamp. She held her breath until it moved closer into the light. A maintenance bot scuttled away on its regular rounds.

She relaxed and said over her shoulder, "By my calculations, we should be dead." Her light illuminated the squeezed path before her like a broad but very low mineshaft. The air smelled stale and metallic. She thought about gremlins and dwarves, tommyknockers and leprechauns. This would be the place they would like, walking unseen below the ark-ship crew's world, causing trouble. She grinned at the idea, but only for an instant; the gray hull's interior absorbed light, accepted no shadows, and it hurt her hands to crawl on it. Next time I'll bring gloves and knee pads, she thought.

Sierra, a few feet back, grunted in acknowledgment. "But we're not dead. That doesn't mean there was anything extraordinary."

Delaney checked a monitor mounted on her wrist. They had inched close to where her calculations said there should be an impact crack. "That's what's troubling me. I've said from the beginning they made a mistake crewing these ships. Too homogeneous. All this scientific expertise creates blind spots. We assume every occurrence has a rational explanation and that's not sensible. Sucks the grand wonder out of living. Strange events have happened on this ship indeed. Sounds behind the walls. Tools moved. Meals missing. Remember when Yamashita lost his glasses? Couldn't find them for a week, and there they were, in the middle of his desk." She scooted forward ten more feet. Naturally, the stressed area would be centered between two access panels. "Aye, remember the rainbow on the day we took off? I see it as a sign, and it's a terrible pity that when I point it out to you, you give me a lecture on light and refraction. They provided racial and ethnic diversity, but not much diversity of thought."

"The problem is you're homesick, Irish girl."

"It's not homesickness. It's just our lives are so . . . so . . . planned. Even our genetics. When we get to Zeta Reticuli, the computer will control our breeding, screen our genes, manipulate them to fit the environment, and twitch and tweak us to keep us healthy. It has mission control. God only knows what all it's up to. We're letting the computer make autonomous decisions. I just think being human means accepting a bit of chance in our lives and staying open to wonder."

Sierra said, "Chance and wonder gave us the mutagen and drove us off Earth. Besides, I like what the computer is doing. Did you taste the new tomatoes at lunch? The botanist claimed they're more resistant to disease and take half the water to grow. That's what happens when you give a computer some decision-making capabilities and eons to work with. Those old people invented gods because they needed to explain how their worlds worked. We engineered ours.

"How much farther? This is tearing up my hands and knees."

"We're there." Delaney checked the monitor again, but the surface appeared uniform and undamaged. She dragged her pack into reach, then removed a sophisticated tester for metal integrity. She *was* homesick. When they'd started the flight a year earlier (by their time—the caretaker crew slept all but two weeks of every hundred years during the previous 2,600 years), homesickness was a

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disregarded triviality. Delaney longed now for the hills south of Letterkenny in Donegal where she'd grown up. No more wind off Trawbreaga Bay and Lough Swilly carrying a hint of salt and faraway North Atlantic storms. No more heather-covered hills.

Sierra said, "The maintenance bots have been all over this section, and they didn't report any breaks."

"I've got to see for myself." Delaney connected the two thumb-sized transmitters a yard apart on the hull, then pressed the diagnostic device's trigger, sending a low-level radiation pulse through the hull, which tested sound until it hit a complicated crack system three feet deep that stretched to the outer surface and airless space. Beyond that, the device didn't measure, but Delaney could imagine the empty light-years to Earth and Ireland, the light-years to Zeta Reticuli. She tried to remember what the morning mist felt like on her last hike to the ancient circular fortress, Grianan of Aileach, where she stood atop the thousands-of-years-old wall waiting for the weather to break. On a clear day, she could see the Swilly estuary, the Inishowen peninsula, and much of Derry, but the fog never broke. Her fingers glided over the cool, damp stones. She'd heard a noise behind her, a quick, light laugh. No one stood in the fortress's circular sward. Empty walls in both directions. It didn't take much to believe there was more to the world than it appeared when she hiked by herself in a land filled with so many stories.

"Nothing close here." She moved six feet and replanted the sensors.

"Which is just what the computer reported. Why can't you admit the hull performed the way it was designed? In a collision, force is *supposed* to be transmitted laterally. That way a speck can't poke all the way through."

"At a quarter light-speed, a wee speck packs one hell of a lot of kinetic energy, and this was much more than a dust mote. The numbers say it was marble-sized. The ship should have shattered like a porcelain egg." She read the results again. The cracks radiated to within a foot of the inner surface.

"I don't get why you're looking for a break in the hull when there isn't one. We'd be freeze-dried and vacuum-packed if there was. Do you hear a breeze? I don't hear a breeze."

Delaney scooted farther forward. "The numbers tell me we should be busted, and we're not, so I'd like to know why."

"For once, the ship exceeded the design specs."

Delaney saw the crack before her monitor reported it to her. The hull had a grain to it from the millions of interwoven carbon-metal threads that gave the ship unprecedented durability, but it needed strength to survive the 4,000-year-long trip to deliver its mostly slumbering caretakers and frozen embryos and colonization gear to the distant planet. Her head lamp showed the break, a long, crooked line across the rough texture. The monitor confirmed it: fissures emanating from the collision led all the way to here, hundreds of yards from the impact spot on the hull's exterior.

It started as a hairline, then widened to as much as a fingernail in thickness, four feet long. Delaney scrinched forward, directing her light onto the hull.

Sierra inhaled sharply. "God! You were right, but it can't be continuous. Not to the surface."

Delaney didn't answer. The monitor told her the story. She pressed her finger against the crack, then looked at the raised mark it left on her skin. "We should be dead."

Sierra offered, "The bots . . ."

"Were knocked out. Two hours without power while the ship rerouted energy and woke us up. Besides, they weld hull breaks. No weld here." She unsnapped a knife from her tool belt, then poked the end into the crack. It was hard to see, since the gap was so narrow, but it didn't appear to be more

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than a half-inch deep. The knife stopped. She jabbed it in again. There was a little give, not like metal against metal. More like digging into wood. She rocked the knife point back and forth. When she brought it out, a white residue coated the end.

"What is it?" asked Sierra.

"We need to get back to the lab." Delaney scraped the residue into an envelope and sealed it.

At the end of Delaney's work shift, Crew Chief Yamashita paused at her station. His uncombed hair covered his forehead, and tiredness bruised the skin beneath his eyes. "Sierra says you found a crack in the hull; a real crack?"

"It's sealed, but that's not what's . . ."

"You mean it didn't breach. Thank goodness for that. The repair squads are working to refurbish the exterior. With some effort, we should be sleeping again in a few days, but it's thrown off everyone's schedule. There's a committee deciding if the next crew should be awakened early, or if we should keep them on cycle. It's an extra seventeen years before the next maintenance that way, but then we'd be back to normal. Plus, we've got to worry if there's another stone like the last one. We shouldn't have hit anything."

Delaney pushed a notebook at him. "Can you look at my numbers?"

He took the notebook in one hand and rubbed his eyebrows with the other. "Couldn't you show me these on your computer? Your handwriting is terrible."

She crossed her arms. "I get different numbers on the computer."

The crew chief handed her the notebook, "Then you made a mistake."

"The crack in the interior wasn't welded."

"It wasn't leaking, either. It just means the maintenance-bots missed it. The system suffered an overstress those first hours."

Before she could even give him a disgusted look, he left. She leaned back in her chair, the notebook in her lap. Above her monitor hung a digital display from home: a long, green hill, sun-streaked and cloud-shadowed. In the foreground stood a whitewashed cottage with a thatched roof. During the summer, she used to explore the hills where the heather and clover and dew-damp smells hung in the air. Folks called Ireland "The Emerald Isle," and they were right. The more she thought, the greener it became. The month before the flight she'd spent seaside at Bundoran in south Donegal, where cliffs bracketed the beach on either side. Waves had carved the stone into fantastic lavender-blue formations, but behind them the hills rose, green on green.

It takes a long time to say goodbye to a country, and she didn't realize she was saying goodbye, *really* realize she was, until it was too late.

She flicked her monitor to the analysis of the white residue she'd found in the crack. She'd asked the computer to identify it and run a match. The results said plastic—the same kind that formed almost every other structure on the ship that wasn't metal. How did plastic end up blocking the deadly crack? What saved the ship during the two hours when the maintenance bots were down?

After a few key clicks, the time line for the collision came up. At zero hundred hours, a marble-sized rock hit *The Redeemer*. Power supplies to the bots and the ship's key systems, including the computer, were interrupted. Computer-independent routines kicked in, warming a caretaker crew and searching for alternate paths around the system breaks. An hour and fifty minutes later, the computer regained ship control. The bots started moving, and after ten minutes the crew awakened to klaxons and emergency lights.

Delaney tapped her finger against the monitor. The bots scurried everywhere in the record. They had to have found

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the crack she'd found. They couldn't miss it. But by then it was already sealed.

Delaney's mattress felt stiff beneath her. Not surprising. It was 2,600 years old, as were the sheets and blankets and the clothes she wore. Everything on the ship had a brittle look to it. The engineers and manufacturers put *The Redeemer* together out of theory and hope. Could humans survive repeated cold-sleep to make the 4,000-year-long trip? Could the ship keep itself repaired? Could the crew remake and recalibrate the ship the hundreds of times it would take to arrive at the distant star? Yes, in theory.

As she tried to sleep, she thought about the computer, a redundantly designed, decentralized intelligence interlaced throughout the ship, capable of independent action, controlling all the systems, directing the toaster-sized, multitooled bots that scurried through the maintenance tunnels like industrious mice. What did the computer do while the caretakers slept? Why didn't her collision calculations done by hand match the numbers the computer spit out? And, most nagging, how did the plastic that saved their lives end up in the crack the bots hadn't found?

After what seemed like hours struggling to find a comfortable position, she drifted on consciousness' self-aware edge, half-hearing the ship, half-hearing her own blood stream's mountain rush. Lazily, she thought of an old lover, long dead now on Earth. She had picked him because he looked like William Butler Yeats, a long face behind black, wire-rimmed glasses. Delaney asked him to read her poetry, and as she settled deeper into sleep, she heard his voice until he blended into the dream, and in the dream he became William Butler Yeats sitting on a rock along the trail to the flat-topped mountain, Benbulbin. Not the old Yeats who wrote "The Second Coming," with its prophetic "rough beast" slouching toward Bethlehem for an unholy birth—the rough beast indeed of the mutagen that had driven them to build the ark-ships and sent them skyward, trusting not everything human need end—but a young man in his midtwenties, the one who collected Irish folktales, who longed to build a small cabin in Innisfree made of clay and wattles where he could live in the bee-loud glade.

Yeats held a walking stick in one hand, and a book lay open on his lap. "What are you looking for, lass, so early on a morning as fine as this?"

But before she could answer his question, a wind came up, and Yeats dissolved into a wisp and the rock was unoccupied. Behind her, something laughed. She turned, and the long trail down the mountain was empty, though there were many limestone boulders a being could hide behind. She thought with a shiver, there must be leprechauns or Sidhe, the fairy folk, and she remembered that not all the Sidhe were benevolent. There were stories of children stolen from cribs and stones left in their place, and lone travelers who vanished on roads considered safe. The realm of Faery could be perilous and its people fierce.

Yeats's voice came from the wisp. "One wonders if the magical creatures came with us from the old lands, or did our living in this new home give them immaculate births? Are they with us because we believe in them, or do we believe in them because they are here?"

Deep in the warehouse module, Delaney found what she'd been searching for: the raw polychloride supplies that served as a base for dozens of plastics the ship might need. Six huge vats standing on stubby legs held the chemicals. Sierra wandered toward the back. "I don't see the point in coming down here. It's been hundreds of years since this area's been used."

The low-ceilinged room absorbed their footsteps. Recessed wall lights illu-

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minated the vat tops, but left the rest in darkness. Delaney imagined steely-eyed little people watching them from the deep shadows. She shook her head, then popped the latch on the first vat and pushed the lid. It resisted for an instant, then the hinges creaked as the lid came up. Grainy white flakes filled it to the top. She dipped her hand in thoughtfully. Plastic, matching what she'd found choking the crack in the hull, fell from her grip like sand. Under the atmospheric pressure from within the ship, the plastic had solidified into an airtight seal. If the crack had been any more than complex fissures, the plastic would have flown into space with their air, but the break had been so narrow and filled with twists and turns that the plastic piled up, expanded and corked the leak. How did it get there?

She massaged her forehead. In the old stories, leprechauns would sometimes do a worthy family a favor. Every culture, it seemed, had stories of little people by various names: elves, fairies, peri, pooka, nymphs, dwarves, gnomes, brownies, goblins, nixes, kobold, trolls, and gremlins.

In her dream, Yeats had asked where the creatures came from. Had they followed humanity from town to town, or did they generate spontaneously from the land? Old Earth was dead now, or dying. Was it possible something other than the thoroughly inventoried supplies, the carefully thought-out stockpiles of embryos and tools and equipment, was aboard *The Redeemer*?

How would it live?

Delaney said, "You checked on air consumption like I asked?"

Sierra peeked over the top of a vat. "Yep. Nothing is breathing on this ship we don't know about. Nor is it eating, drinking or processing waste. I suppose you'll say that confirms a supernatural explanation."

"I like the *idea* of the supernatural. That doesn't mean I believe that's what happened. How'd the plastic end up in the breach?"

"Maybe there was plastic residue on the hull?"

Sierra's tone showed even she thought the explanation was weak. Delaney shut the lid and relatched it.

"Ah, ha!" said Sierra. "Take a look at this."

Delaney hurried past the vats, squeezing between the last one and the storage lockers that made up the wall. Sierra knelt. "See, there doesn't have to be a supernatural component. Rationality rules."

On the floor sat a white pile of plastic, spilled from a small rupture in the tank's back. Sierra said, "So, some plastic *wasn't* in the vats."

Delaney dropped to her knees, pushed her finger into the gap, provoking a mini avalanche. "Huh! It's a long way from this room to the crack in the hull. How did it get from here to there?"

"One problem down, one to solve," said Sierra triumphantly. "Maybe this time luck chose our side."

"Luck of the Irish?" asked Delaney.

Above Delaney's head, from an air vent, came a quick scratching, like twigs on metal. She looked up. "Did you hear that?"

Sierra looked up too. "No. What was it?"

Delaney held her breath, waiting for the sound to repeat. "I don't think it was a bot." She contemplated the white pile on the floor. "The bots should have caught this long ago."

Sierra leaned her back against a locker, studying the ceiling nervously. "Are you sure you heard a noise?" A distinct thump of thin metal rebounding echoed through the room, as if something weighty had moved in the air duct. Sierra jumped, then rubbed her arms, still looking up. "The bots are practically perfect. They never miss stuff." She stood, holding her elbows tight, her arms close to her side as if she were cold.

"You're right; they shouldn't. Let's go

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back to my station. I want to check something."

Before she closed the door to the module, Delaney looked back into the room. It didn't take much to picture faces in the dark, to see tiny fingers wrapped around the air vent where hidden creatures studied her.

Delaney said, "We have to eliminate possibilities. Could a caretaker have been awake during the collision?"

Sierra consulted her monitor. "According to the computer records, no."

"Could the computer be wrong?"

"Not likely. Not only does it keep track of where everyone is, but each sleep tank has its own start-up and shutdown history. I checked all fifty of our shift's tanks, and also the hundred-and-fifty tanks from the other three shifts. No caretaker was awake."

"Is it possible there's another person on board who never uses the sleep tanks?"

Sierra laughed. "He'd be over 2,600 years old." She sobered. "I haven't been able to explain it. So I ran an analysis of duty logs since the trip started, and from nine hundred years or so ago, the incidence of unexplainable phenomena began going up. Not just misplaced tools either. Clothing has been moved. Doors open that should be closed. Repairs made that weren't ordered. All kinds of stuff. If you look into the public journals, there's dozens of odd reports. Crew members have recorded feelings like they're being watched, or that something moved in the corner of their eye. It gives me the creeps. The computer reports nothing. Maybe we do have gremlins."

"Leprechauns," Delaney said absently. "We're missing a bet, here. There's a factor we're overlooking. I'm going to put some equipment together. Come back tomorrow. I'll need your help again."

Sierra looked pained. "Yamashita says we go back into the sleep pods in two days. I don't like leaving the ship to ghosts and other slithery creatures while I'm unconscious. Do you think they come look at us?" She shivered.

"Now look at who's not being rational."

"It's your fault. If something else lived on board, there would be computer records, but there's nothing there. *Something* put the plastic into the breach, and the best explanation is your leprechauns. We're on a possessed or infested ship." Sierra tightened her hands until her knuckles whitened bright as paper. "I'm not sleeping tonight. I'm not sleeping ever again."

"Come back tomorrow." Delaney put her hand on Sierra's shoulder, feeling muscles rock-tight and trembling.

After Sierra left, Delaney gathered her supplies. First, to the kitchen for bread and cheese, and then to the electronics warehouse. Finally she visited cryogenic storage, where drawer after drawer of frozen, fertilized ova waited for their test-tube births, all the animals for the new planet. She searched for over an hour, opening one drawer after another until she found what she'd been looking for—missing ova.

As she set up the equipment in the access crawlway, near where she'd discovered the sealed crack, she remembered Yeats wrote that the people of Faery could not even play catch without mortal help. Without help, they were too shadowy and could not lift the ball.

When Sierra entered the room, Delaney could tell she hadn't been sleeping. Her face was haggard and her hair uncombed. "I ran a zillion scenarios on the computer last night, and none add up to an explanation. It's not rational."

Delaney smiled. For the first time in days, she felt both excited and relaxed. "I have some recorded video I want you to watch. Take a seat."

Sierra collapsed on a chair. "If it's more than a couple of minutes, I'll drift right off."

"Oh, I think you'll stay awake for

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this." Delaney pressed a button that flashed an image onto her desk monitor.

Sierra leaned forward. "What's that? It looks like bread and something else."

"Cheese." Delaney forwarded the image, keeping an eye on the time record. "Watch close."

Sierra shook her head, puzzled. "Where is this? Why's it so poorly lit?"

"The maintenance crawlway."

"There isn't a camera there. Is that from a bot?"

"No. It's one I rigged to transmit its images straight to here. Hush, now."

The two women studied the screen.

"There!" said Delaney. A long, fuzzy, shadowed shape reached from one side, grabbed a piece of bread, then disappeared.

"What the hell was that?" Sierra gripped the desk's edge, her face inches from the monitor. Delaney hadn't seen her get out of her chair.

"Wait, there's more."

This time the movement was slower. Whatever it was stood too close to the camera to be focused. It blocked the image, turning the screen black. Then, it turned, squatting beside the cheese, still dark and nebulous until it straightened, the rest of the bread and cheese in its arms. It looked toward the camera as if sensing the spying presence. For a instant the light was right, and the creature's eyes were clear, its large, round head distinct. The neck was thick and short, the hands at the ends of furry arms were hairless and tipped with tiny claws. It vanished again.

Sierra gasped, "Is that a . . . leprechaun?"

Delaney laughed. "No, it's a mouse. Or its great-great-great-grandfather was a mouse."

"A mouse! What do you mean? It's a foot-and-a-half tall if it's an inch." Sierra touched the monitor where Delaney had backed up the image to the face in the dark, its arms full of cheese and bread.

"I went over all the data you collected last night. The absence of evidence. No video of anything untoward. No record of increased air, food or water consumption. Nothing indicated the presence of other beings on board the ship, and yet it was obvious we weren't alone. You know the common factor in all my unsuccessful searches?"

Sierra looked baffled. "No."

"The computer. All my questions went through the computer. The searches went through the computer. What tipped me off were the numbers on the collision. When I did them by hand, there was enough force from the collision to produce the crack we found, but the computer kept giving me smaller numbers. The computer didn't want us to find the crack."

"You think the computer *made* the leprechauns?"

"I know so. From mice embryos. I found the empty capsules in the cryogenics room. When I confronted the computer with the evidence, blocked files by the dozen tumbled free. There's a complete record of the breeding program. There's a leprechaun nursery deep in the maintenance shafts where the bots can get to, but we wouldn't go. All the records had been faked to hide their existence."

Sierra sat again. Her gaze wandered around the room. Delaney guessed she was searching for something to say.

"Why would the computer do it?" Sierra paused. "Oh, give me a second. It must have calculated the possibility of just the situation we faced, where all the power would be down. The computer's designed to operate without our input. It decided an always-awake, sentient work force was necessary." She laughed. "And the computer guessed right. We're alive today because the leprechauns poured plastic into the breach. God, that's brilliant. How smart do you think they are? How does the computer communicate with them? The biology people are going to have a field day. Have you told Yamashita? I can't wait to see

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his face. There's nothing supernatural at all, and I can get some sleep."

Sierra rushed from the room before Delaney could speak.

She looked at the Irish landscape mounted on her wall and remembered how old and spirit-haunted the stones of Grianan of Aileach felt beneath her hand on her last visit. Sierra's theory was a reasonable one; it might even be right, but she thought of the traditional gods, the storied ones, how they must have waited alone and lonely on the empty Earth. They must have been a wee bit bored as the years ticked by. She imagined the computer presiding over the ship's lifeless halls, year after year. How autonomous was it? Was it capable too of boredom, of loneliness?

And what of the leprechauns? They had another 1,400 years before *The Redeemer* arrived at Zeta Reticuli. The years passed slowly as the crew slept, and what would the leprechauns do during that time? On her monitor stood the frozen image she'd captured, the little creature with its arms full of food, its eyes reflecting the dim light that shone in its dark world below her own. Not all the stories of the Sidhe were good ones. The Faery folk of Irish legend didn't live to serve man. They had separate desires. Did these new creatures have hopes of their own?

Delaney shut her eyes and sighed. She'd found a rational explanation—full of wonder to be sure, but rational just the same. It was a long way from Ireland, a long way from the Emerald Isle. And she wasn't sure she'd be able to sleep as securely as Sierra. ■

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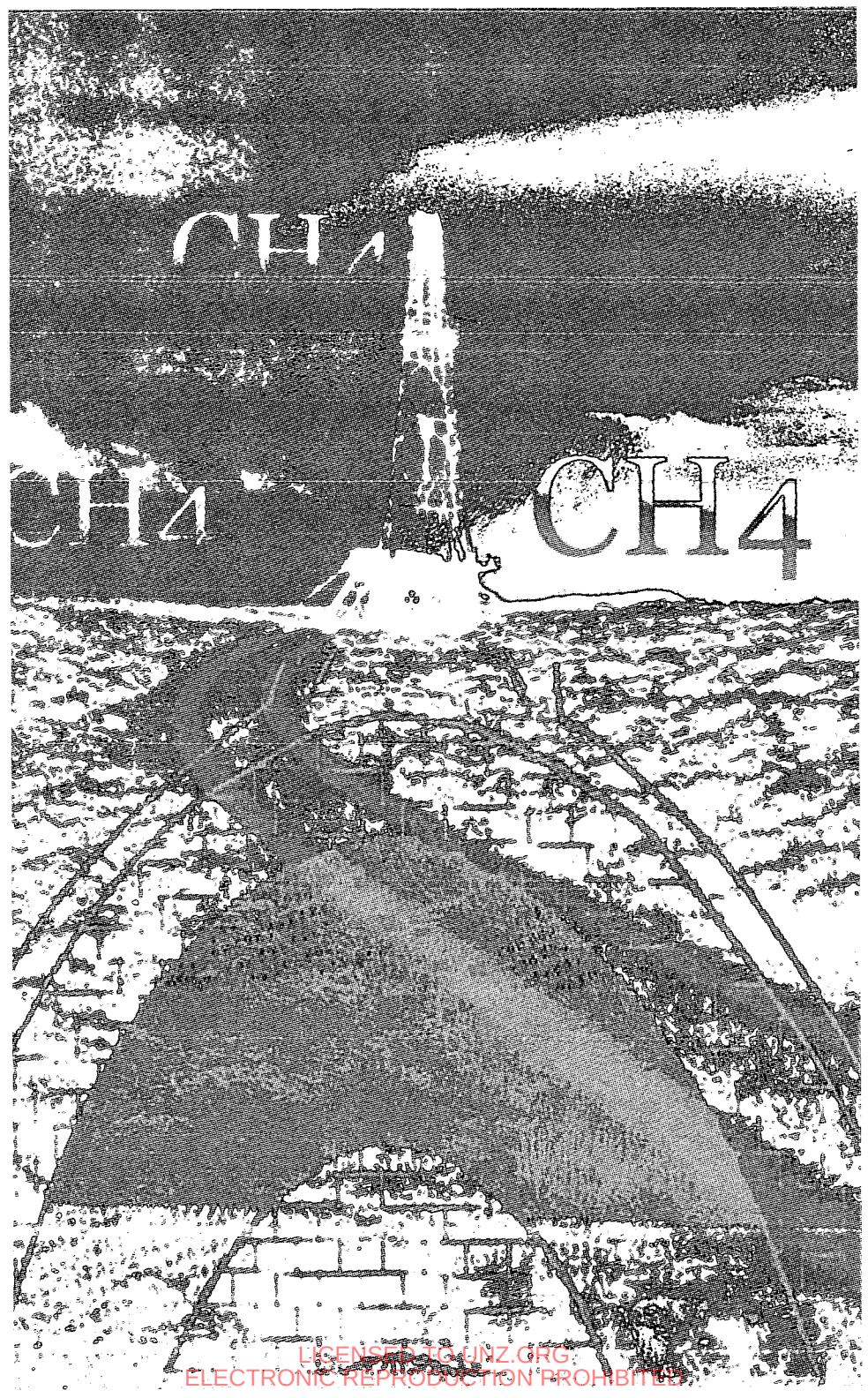

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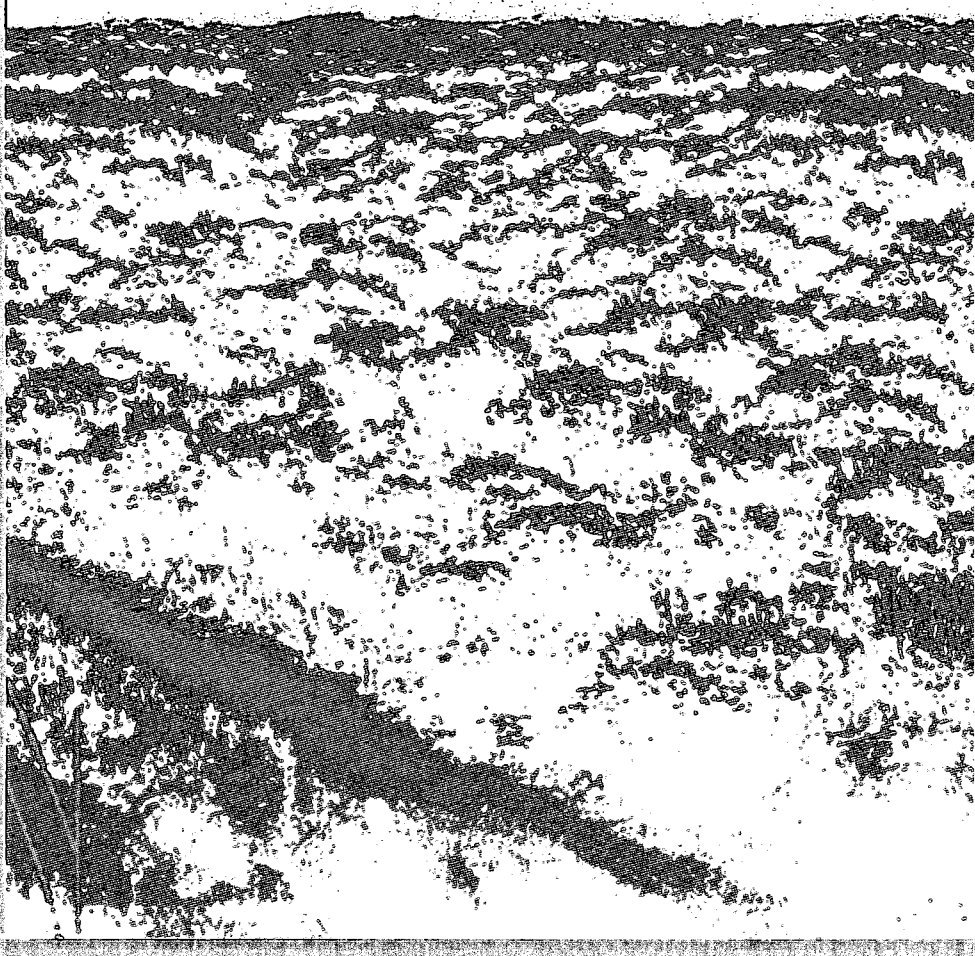
Renewable Resources

Jerry Oltion
Illustration by Broeck Steadman

Looking at one problem at a time may not be enough.



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"You've made your bed," the letter said. "Now lay in it." That was the whole message. Neatly typed, with an inside address and a date—two days ago, Tucker noted, the same day it was mailed. Act in haste, repent at leisure, as the old saying went, but he didn't suppose the sender regretted this one. There was no return address, of course. No telling what an enraged oilman like Tucker would do if he caught the author. Probably teach him the difference between "lay" and "lie."

There was no need for a longer letter. Tucker got the message loud and clear. The author of this little missive missile, like so many other people in Wyoming, wanted to see him fry in regulatory hell.

Of course they also wanted electricity to run their homes, and gasoline to run their pickup trucks and SUVs, and natural gas for heat, but they didn't want it to come out of their own back yards. Not without making the drillers promise they'd preserve every flower and bird and toad and bug that lived there, never mind that they'd already grazed cattle and sheep on the land until the native grass was gone and nothing would grow but sagebrush. They wanted the drilling site to look like virgin prairie, and they were going to make sure Tucker left it that way.

Plus he had to find an environmentally friendly use for the water. That was the latest bombshell. Extracting methane from a coal seam produced thousands of gallons of water, which the Environmental Protection Agency now classified as a nonrenewable resource. They said rainwater wouldn't refill the aquifers in anything less than geologic time, which made the groundwater a "fossil" resource, and as such Tucker couldn't just pump it onto the ground. He had to come up with a use for it that would justify depleting the aquifers. Not just any use, either; it had to be the best use that anyone could demonstrate.

Irrigation would qualify, but so far he hadn't been able to find a buyer. A person would think that in a state that got only twelve inches of rain a year, water would be easy to sell, but the local ranchers had been getting government-subsidized irrigation water out of the Bighorn Mountains for so long he couldn't charge them enough to recover his pumping costs.

He might find it hard to give away. Even if he could find someone who wanted it, with all the public outcry against coal-bed methane extraction, nobody would sink any money into building a pipeline for a water source that might dry up on them in six months if the environmentalists succeeded in shutting Tucker down.

He dropped the letter onto the stack. In the week since the *Sheridan Press* article on his appeal of the EPA decision, his pile of hate mail had grown until it was almost as high as the stack of government forms he had yet to fill out. That would teach him to protest when people wanted him to do the impossible. He should apparently just roll over and do it.

He wondered how many of his detractors would be surprised if they saw his office. They probably expected a mahogany-paneled suite across the hallway from Senator Thomas, with a conference room stained gray from the cigar smoke of all the fat cats making closed-door deals. If they saw his single-wide modular in the mudlot behind the Burger King, with its metal desks and Wal-Mart steno chairs, they would probably think it was a front.

That might be more true than they thought, if Tucker couldn't pull everything together. He had investors all over the globe pouring money into this project, and if he didn't produce some methane soon, he could easily find himself being investigated for fraud.

New startups were always a risk, but somebody had to try them. In the oil industry, that somebody was usually a major company with bottomless pockets,

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but this time the hot new thing didn't require anything Tucker didn't already have. All a person had to do was drill into a flooded coal seam, pump the water out, and collect the methane that boiled off when the pressure dropped. Anybody with a drilling rig could do it, provided they could wade through the ever-changing thicket of regulations the government kept imposing.

He looked at the stack of mail still unopened, then at the computer, where he still needed to check his email. After that, he was supposed to fill out the monthly OGOR—the Oil & Gas Operations Report—and an investors' report, which would take him far into the afternoon before he actually made it out to the well site.

He looked out the window. Sunny and warm—for April, anyway. A great day to be outside. And here he sat, pushing paper while Pete and Gordy and the crew out on the rig had all the fun.

The letter on the top of the pile drew his attention once more. "You've made your bed, now lay in it."

"I didn't make this one," he said. He grabbed his coat off the nail in the wall and slammed the door hard enough to rattle windows on the way out.

There was a car parked at the drilling site's property boundary. Two people had been sitting in it, no doubt to escape the chill breeze that blew across the badlands east of the Bighorns, but they climbed out when they saw his pickup approaching and lay down in the middle of the gravel road. That was a new one. Tucker had heard of people chaining themselves to trees and lying down in front of log trucks, but they'd never tried to block a drilling site out in the middle of nowhere before. At least not one of his. They were too late, anyway; Pete and Gordy and the two hired hands were already on the rig. But these two protesters stretched out head to head right in front of the cattle guard so Tucker couldn't drive around them. He didn't know whether to call their bluff or just pick them up and pitch them into the ditch, but when he got a look at their car, he pulled to a stop beside it and got out.

"Hey, is that a ZEVon?" he asked.

The two guys—no, it was a guy and a girl, both thin as rails and shivering in their useless Levi jackets and baggy pants—looked up at him as if he'd just spoken Greek.

"What?" the guy said.

"Your car," Tucker said. "It's electric, isn't it?"

"Yeah."

"Can I have a look?"

The guy propped himself up on an elbow and squinted to see against the Sun. "You're Tucker Beck, aren't you?"

"In the flesh." Tucker held out his hand, but the kid didn't take it, nor did he get up. Tucker shrugged and walked over to the car. Sure enough, the streamlined silver teardrop had the lightning-bolt ZEVon logo on the hood. The tires were nearly covered by the fenders, and the back sloped downward at a true aerodynamic angle; not the false looks-like-it-should-be-efficient-but-really-isn't pointy nose and blunt butt of most cars on the road.

"How far do you get on a charge?"

The girl sat up, too. "We're not moving," she said.

"Suit yourself. So what do you get? Eighty miles? A hundred?"

"A hundred and seventy," the guy said, unable to keep the note of pride from his voice.

"No shit? And how long to charge it?"

"Half an hour."

"That's incredible. If McDonald's doesn't have a recharge franchise in the works, they're idiots."

"Huh?" the girl asked.

"A half-hour recharge is just enough time for a burger and a Coke. McDonald's would be the perfect place to set up recharge stations."

She looked at him like he had just suggested they start serving baby meat. "Do

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you always look for the money angle in everything?"

He scratched his head. "No, but that one's a no-brainer."

"Like pumping the entire basin dry to get methane?"

Ah, here it came. Protesters always had to get their zingers in. He decided to see if he could cut them off at the pass.

"So how big's your solar array?" he asked.

"Huh?" she asked, right on cue.

"The solar array you use to recharge this car."

"That's not how it works."

"Oh, so you have a wind generator."

"Uh . . . no."

"Geothermal? But you'd have to drill for that, and you'd never get the permit application past the EPA just for personal use." He narrowed his eyes as if the thought had just occurred to him. "You don't . . . get your power off the grid, do you?"

Neither of them answered him.

"I mean, because if you do, you're getting it from a power plant, which is either killing fish if it's a hydro plant, or polluting the air if it's coal-fired, or piling up radioactive waste if it's nuclear. Natural-gas-fired plants are pretty clean, but, well, here you are."

He waited a few seconds, then opened his pickup door. "While you're thinking it over, you mind if I go on down to the well to make sure we're providing enough gas to keep you on the road?"

That put them back on more familiar ground. "We're not moving," the girl said.

"Fine with me," he said, "but it's going to get mighty cold there on that gravel." He climbed up into the seat and started the engine.

The protesters lay back down. Tucker put the truck in reverse and backed away from them, then put it in first and turned off the road, down into the barrow ditch. He drove straight at the barbed wire fence, aiming for a spot between two posts, and didn't slow down when the grille and bumper hit the wire. Metal squealed against metal, and three distinct bass notes twanged out above the rumble of the engine.

Tucker glanced over at the protesters as he drove past. They were both on their bellies with their hands over their heads, like soldiers under fire. He knew just how they felt.

He would have to fix the fence before anybody's cows got through, but he hadn't seen any cattle close to the drill site all week, so there was no big rush.

The rig was roaring away when he got there, the big diesel engine running flat out under load. Gordy and the two hired crew were hustling around like they were actually busy, but Tucker could see half a stand of pipe still above the kelly, so he knew they were just putting on a show because they had seen him coming.

Sure enough, when he climbed up to the doghouse, Gordy leaned close and shouted over the roar of the engine, "Nice driving!"

Tucker shrugged and rolled his eyes. "Everything okay here?"

"Yah. Nobody's touched anything. And check out the rock samples." Gordy pointed at a glass jar full of water and reddish brown rock chips. "We're damned near to the coal seam. Another day at most."

"Good." Maybe Tucker could hold off on the investors' report long enough to actually *have* something to report. "Pumps ready to go?" he asked.

"Pete's working on 'em now. They'll be ready when we need 'em."

Now all they needed was a use for the water. The methane compressor was ready, and the feed line to the interstate distribution pipeline, but they couldn't start pumping until they could satisfy the EPA that the water wasn't being wasted.

He looked at the output line for the water pumps; a bright white PVC pipe no bigger than his arm aimed out into the sagebrush about a hundred yards away. The flow rate wouldn't be much

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more than a residential water well, but when you pumped ten gallons per minute, day in and day out, it added up. Tucker had planned to let it spread out into a shallow pond with a marsh at the edges, blending into the marsh and the pond around pump number two, and so on down the line if the project worked out.

Not now. Unless he could convince the EPA that creating ponds and marshes was the best use of the water.

Maybe he could plant trees around the edge of the ponds. He could stock the water with fish, set up picnic tables, and promote the well sites as public parks. That would turn the tables on the greenies.

Or maybe he could plant rice. Start a whole new branch of agriculture for the government to throw subsidies at. Yeah, right. And if he put a sow on the well head and lit a match, pigs could fly.

He climbed into his truck and drove back down the road toward the protesters, expecting more trouble from them on the way out, but they were already gone. His little victory on the way in seemed pretty minor compared to the hurdles he had yet to jump, but he wasn't going to let the damned hypocrites shut him down. Let 'em barricade the roads, and let 'em pass all the regulations they wanted; they still needed fuel and they weren't going to get it from OPEC forever. When the Arabs put the screws to them, then they would start clamoring for domestic sources, and he would still be here, ready to yank their sorry butts out of the sling.

Not that he expected thanks, or even wanted it. If they would just quit pissing on him, that would be enough.

There was plenty of extra wire to splice the fence with; it had stretched at least a foot before it had broken. Tucker twisted the ends together and cranked them tight with a pair of ViseGrips, then drove on.

He caught up with the electric car on the way back to Sheridan. It was nosed over toward the side of the road halfway up the long grade out of Monarch Flat. The two greenies were sitting inside, looking glum. Tucker parked behind them and walked up to the driver's door.

"You guys okay?"

The girl was behind the wheel. She looked up at him, then rolled down her window an inch.

"What do you want?"

"Well, I thought I'd offer you a ride if you needed it."

"We're fine."

"You sure? It looks like you ran out of juice."

"So what's it to you if we did?"

"Like I just said, I'll give you a ride into town if you need it. It's a long walk from here, and you guys aren't exactly dressed for cold weather."

"We're fine," she said again.

"Suit yourself." Tucker turned away to walk back to his pickup, but the look on the face of the kid in the passenger seat stopped him. The guy looked like he expected to die of exposure in about ten minutes.

They would be okay if they stayed inside their car, but Tucker couldn't resist the opportunity. He turned back around and said, "Look, this stretch of road gets about five vehicles a day, and all of 'em are oilfield rigs. It's going to be a long night out here with no heater if you don't want to ride with one of us."

The girl opened her mouth to speak, but her boyfriend said, "I'll go. You stay here and wait for me to come back."

"That's dumb," Tucker said. He leaned down so he could talk to the kid through the tiny slice of open window. "No offense, but you shouldn't split up when you get into trouble on the road."

"So says the personification of trouble," the girl said.

Tucker put his hand out to steady himself against the car. "You know, I could take that personally, but I'm feelin' generous today. One last time. You want a ride back to town, or you want to shiver out here all night?"

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"We'll take the ride," the guy said.

"Smart man. Grab your stuff and come on." Tucker went back to his pickup and cleared off the passenger half of the seat. He tossed his coveralls and hardhat in the truck bed with the tools and pipe fittings, then he popped open the door from inside and waited for the two kids to climb in. The boyfriend stopped to look at the barbed-wire scratches in the front of the pickup. The girl marched past him, but she waited for him to climb in first. He sat in the middle, and she sat as close to the door as she could.

"We're armed," she said when Tucker started the engine.

"Congratulations." He put the truck into gear and let out the clutch a little too fast, cranking the wheels to the left just in time to miss the back end of their car. "So why'd you run out of juice? Runnin' the heater?"

Silence.

"Thought so."

They crested the hill and started down the other side. The pickup shuddered over the washboard ruts, but Tucker didn't slow down. He'd tried that, and he'd tried driving fast, and he'd tried driving with one tire on the shoulder and the other on the center hump, but nothing helped.

He looked over at his passengers, trying to decide how old they were. Twenty? That would be the upper end. "What's your names?" he asked, talking loud to be heard over the vibrating suspension and the clatter of tools and junk rattling around under the seat.

"John," said the boy after a few seconds' thought.

"Jane," said the girl.

"Right. What would you do with the water?"

"Huh?"

"The water you're so upset about. What would you do with it if you were me?"

"Leave it in the ground."

"So you'd rather dig up the coal seam and let the methane boil into the atmosphere? It's a greenhouse gas, you know. Worse than carbon dioxide."

"You should leave the coal in the ground, too." Jane was doing all the talking, but Tucker couldn't bring himself to think of her as the brains behind their operation.

"We've been through that already. You want to convince America to go solar, we can quit burning fossil fuel, but until that happens, don't talk to me about leaving the next best energy source in the ground."

"It's nonrenewable," Jane said. "You burn it all up, it's gone forever."

Tucker laughed. "That's such bullshit. Where do you think hydrocarbons came from in the first place? The laws of physics didn't change at the end of the Mesozoic era. There's coal beds forming in coastal wetlands all around the globe."

"Oh, sure, and we're burning it up how many times as fast as it's forming?"

The truck shuddered through another patch of washboards. When he could hear his own voice again, he said, "Now that's a good point. So maybe we should be helping it along."

"What?"

"Coal formation."

"What?"

"You environmental activists are always harping about how we should take the long view; I'm just taking your advice. If we're burning up coal and oil faster than it's being produced, then maybe we should start new coal beds. Plant trees. Let 'em pull carbon dioxide out of the air and build it up on the forest floor for a few million years, and then cover it over with dirt for a few more million, and—"

"Oh, sure, like anybody'd actually do that. The minute the trees get big enough for timber, you'll just cut 'em down to make two-by-fours."

Tucker laughed. "Not me, sister. It's tough enough to get a drilling permit in this state. You should try running a

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clearcut application through the Forest Service if you really want a good time."

Her boyfriend opened his mouth to say something, but she beat him to it. "Why can't you just leave nature alone?"

"Because I'm part of it." He waved a hand out toward the badlands stretching into the distance. "Things change, and they do it with or without our help. That was all forest a few million years ago. Fern and equisetum fifty feet high. People didn't cut it down, but we could bring it back if we wanted to."

"What about the sagebrush?" Jane demanded.

"What about it?"

"If you plant trees, it'll kill the sagebrush, won't it?"

"It might. But it's not like the stuff's endangered."

"It doesn't have to be endangered to make it worth protecting."

The washboards drowned out anything more she might have said. He looked past her boyfriend at her, a thin waif of a girl with dirty blonde hair and a scowl that put wrinkles around her mouth. "Have you ever heard an idea you *liked?*" he asked.

She just scowled deeper and looked out the window. Conversation over.

Tucker switched on the radio. KWYO was playing George Thorogood's "Bad to the Bone," so he cranked it up, but "John" reached out and turned the volume down.

"Could you really make a forest grow out there?"

Tucker gave it a moment's serious thought. "Probably. It wouldn't be the same forest it used to be, because half the stuff that grew back then is extinct now, but we could get trees to grow. The climate isn't actually all that different than it was. It's dry, but a mature forest transpires enough moisture into the air to create its own rain. I'd need about twenty years of outside water supply to get it started, and I'd have to plant half the Powder River Basin to actually affect the weather patterns, but once the trees got established, they'd do the job themselves. It was the Ice Age that killed the ancient forest, not drought."

He laughed at the absurdity—and the possibility—of it. Planting trees wouldn't stop people from burning fossil fuel faster than it was created, but it would be a step in the right direction. And maybe, coming from the opposite side of the ideological divide, the idea would catch on.

The kids were both eyeing him warily, probably waiting for him to tell them it was all a big joke. Maybe it was, but if so, then Tucker was just as much the butt of it as they were, because the more he thought about it, the better he liked it.

"Hell, I've got the water. And it would be a piece of cake to lease the land from the ranchers. Forest's worth a hell of a lot more than prairie, and there's more grazing in a forest than what they've got now, that's for sure. Maybe I should list 'reforestation' as the end use in my EPA application. They'd have a hard time denying that."

Jane snorted, but John said, "My dad replants clearcuts for a living. You want his number?"

The gravel road T-boned into Highway 87. Tucker turned onto the pavement and accelerated, the truck sounding unnaturally quiet after the washboard gravel. Did he want to pursue this? It was just a dumb spur-of-the-moment idea, probably fraught with hidden pitfalls. Probably fraught with not-so-hidden ones, too, like the girl leaning up against the passenger door who already opposed everything he stood for just on general principles. He could imagine the phone calls she would be making in the next few days.

Let her call. Anything worth doing was worth fighting for. And he couldn't wait to see the letters accusing him of ruining the environment by planting trees.

"Sure," he said. "Give me the number." ■

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Chrysalis

Larry Niven

Disagreements among siblings are common, but few are quite like this!

After *Apparent Dischord* 's lander docked, the Flutterbies came to the Draco Tavern every day.

The Chirpsithra called their kind something multisyllabic, with a juicy sound. My translator rendered this as "Flutterby." There were seven. They more nearly resembled caterpillars: segmented worms with a couple of dozen frail legs that bunched up near a complicated face with a triple jaw. They weighed half what I did. In Siberian winter they didn't use pressure suits, nor even clothing for warmth, but backpacks rode behind their heads.

They'd enter through the long-and-low airlock and split up. They were gregarious: they mixed with their fellow travelers and humans too. I spent an hour listening to two of them argue philosophy with a grad student from Washburn U., veering over into quantum physics and astrophysics and evolutionary theory, hitting her in stereo, shooting down every theory she raised.

On the seventh day, one Flutterby stayed behind when the rest left. She said, "I hope you will hire me to wait on tables."

The idea tickled me. I'd never had an alien working in the tavern. Besides, I needed a replacement for Gail, who had gone off aboard *Chimes in Harmony* to find the Old Mind and wouldn't be back until after I was dead.

Of course I could see problems. "Your environmental designation—"

"Tee tee asterisk squiggle ool," she said, "but my supplement box compensates." The caterpillar lifted a feeler to tap the flat bag that rode her back. "I can tolerate a tee tee hatch nex ool environment and Earth's temperature and humidity spectrum. Ultraviolet light would be dangerous; will I need to spend time outside?"

"No. Why do you want to do this?"

"My reasons will not harm you nor your dependents. I will work for food and shelter."

I asked, "Are you underage?"

Our translators may have botched that. She said, "I am older than you are. Child labor laws cannot apply. Wish you to know if I am an adult? Of course not. I am an incipient female, maturity delayed. Wish you to know if I can bind myself with promises? I can."

Aurora didn't have a name until I gave her one.

Aurora worked for scale: there's a union in Mt. Forel Town. Still, scale is cheap. My staff has to face daily crises never described outside of old science fiction magazines. They all have doctorates, and they all work for high salaries.

Food and housing might have been a

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problem, but Aurora had said that nourishment was covered. Her backbag included a supplement box that would take care of allergies and dietary deficiencies, and the "ool" designation gave her an herbivorous but flexible diet. As for housing, I had to improvise. The food storage lockers under the Tavern are versatile—they have to be—so we reprogrammed one of those.

Some of the human anthropologists who came in were surprised and amused. I don't believe any of my alien customers were startled to find Aurora serving their drinks and such, barring one, and that was her own species.

They wriggled in through the long-and-low airlock, all six of them, two days after Aurora started work. They ordered as usual: a green glop, rich in fiber, stored cool but not frozen, and they needed *lots*. I sent Aurora with it. Their eyestalks avoided her, scanned in wide arcs around her and the big bowl of glop, as they slithered toward the long-and-low airlock. One stopped to register a credit to pay for the abandoned order. They didn't speak to Aurora.

Aurora seemed pleased afterward. When I asked her about it, she claimed it was personal, swore it wouldn't affect the Draco Tavern's business, and refused to speak further on the subject.

The Chirpsithra run the interstellar liners. They're talkative creatures who claim to own the galaxy. They do, if you only count red dwarf stars. The Draco Tavern was built according to their plans, and partly financed by them too. They're generally eager to help when problems arise. But when something annoys them, I've known them to play practical jokes.

So I try not to bother the Chirpsithra every time I need data. I have other options.

For instance: the translator devices. They have access to a vast library. It's hard to believe that something that fits in a large pocket or small purse carries that much storage, but it certainly doesn't use the computers on the Chirpsithra liners. The liners orbit the Moon. There would be a lightspeed delay, and there isn't.

I think the pocket translators must be artificial intelligences in their own right.

I tried: {Flutterby [with a "species" suffix} + immature + employment} and got this: Plant eater, carbon base, rocky/oxygen/water world, G4 sun. Interplanetary-level industry. Immature Flutterbies above sixty-one point eight kilograms may enter binding contracts to perform service. Servants and machinery take one pronoun; citizens take another.

(Slaves were equivalent to machinery? That sounded like a rigid caste system at work.)

{Flutterby + travel} got me too much material, a long lifetime's study. {Flutterby + interstellar travel + contractual} told me what hundreds of the Flutterby species had done to themselves in order to ride the Chirpsithra liners. Armed with that I confronted Aurora.

It was a dead morning: just us two and a sessile creature drinking alone. I asked, "How old are you, Aurora?"

"In Earth orbits, near seventy," she said, "ship time. Longer than that given relativistic effects." She reared up to polish the big mirror over the bar, avoiding my eyes, catching them anyway in the reflection. "We postpone our maturity by chemical means."

"I can see wanting to live a long time," I said. "Why not grow up first?"

"Rick, how can you bear to ask such personal questions of a waitron?"

"Why not?"

"But we are not of similar caste and rank!"

"I'm your boss," I said. "I'd be handicapped if I didn't know something about you."

Her eyestalks telescoped forward and

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back, studying me. "Very well. Our mature form is little more than a sex organ with wings. We have no digestive organs and little brains. We live ten or eleven days after we emerge from chrysalis form," Aurora said. "I surmise that biotamperers among the Gligstith(click)optok or Chirpsithra might contrive to make an adult Flutterby immortal, and even find some way to keep her from starving. But she would be decoration, not companion. Companions, citizens, *minds* are found only in children. When an elder becomes a chrysalis, she has younger sibs and children of sibs to protect her until she emerges to fly. Over hundreds of thousands of orbits our line has evolved to live longer, to postpone the mating flight so that we may become more capable of defending our genetic line."

"These other Flutterbies, are they your sibs?"

"They are my mating group—wives and husbands," the translator said.

"Why did they leave when they saw you?"

"I have changed caste/rank. They don't know what to do," she said smugly. "They can order service of me, but only in context of our positions. Else they cannot speak to me, cannot persuade me to . . . persuade me of anything."

"What would they want from you?"

"To go home."

"Then what? Set your metabolism running again? Become an adult?" She avoided my eyes. I asked, "Mate?"

"Mate and breed and die," she affirmed.

"What do *you* want, Aurora?"

"Stay here. Work here. Wait until my mating group leaves Earth."

"What if they don't leave?"

"Their berths are aboard *Apparent Dischord.* They would lose those, as will I. When the next ship arrives, I may try to get a berth. Then again, your Draco Tavern is a convergence of voyagers. Here I would find a life as interesting as theirs."

The Flutterbies boycotted the Draco Tavern for about four months.

Then, on a day when rumor suggested that *Apparent Dischord* 's time was running short, all six Flutterbies filed in and split into pairs.

The tavern was crowded. They found conversations rapidly. Corliss and Jehaneh went to take orders and didn't come back.

The philosophy grad student, Berda Wilsonn, had returned with a classmate. They'd chosen a big table, inviting company. A Chirp officer joined them, then two Flutterbies. The others all raised their lift chairs two feet off the floor, to match the height of the Chirpsithra.

I eavesdropped a little. At the Wilsonn table it sounded like they were discussing fear. At other tables, Corliss and Jehaneh were both bogged down in conversations, overcomplex orders, discussions of cuisine. . . .

It looked to me like some kind of setup.

Well, if it turned sticky, there were Chirpsithra present. I could turn to them as authorities. I left Aurora behind the bar and went to Wilsonn's table to take their orders myself.

The Chirpsithra said, "Please, will you have an Irish coffee with us, Rick?"

"It's a busy . . . yes, of course, glad to." I dismissed the notion of begging off. The Chirp bore rank markings: she was an officer. If this was a game, I could assume she was a player. I sat down, glanced at Aurora behind the bar.

The Chirp asked, "What are you afraid of, Rick?"

"What, *now?*"

"I mean in the general sense."

"Lots of things," I said. "Pain. Injury. Taxes. Weird new laws. You?"

"Change, death, ignorance," she said. "You have seen how little we Chirpsithra tolerate change, how assiduously we avoid death. We seek knowledge everywhere."

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"But don't all living things avoid change and death? And hey, animals generally evolve better senses as they get more complex."

"These are not universals," said the Chirp. "Berda, would you repeat—"

"I said I sometimes have nightmares about making social mistakes," Berda Wilsonn said. "Wouldn't that be fear of ignorance?"

I asked, "What about pain?"

Aurora arrived.

The Chirp officer already had a sparker. I asked for cappuccino: I'd better lay off the alcohol. While Aurora took our orders, the Flutterbies and the grads talked. I hate that. *Never let a waiter escape* isn't slavery; it just means don't leave the poor waitron standing there while you talk around her. Anyway, the crosstalk was confusing my translator.

Humans, it seemed, were afraid of nearly everything.

Many species were afraid of death. Others feared loss of mind, loss of intelligence. I've hunted with the Folk; I said they were afraid of nothing. Damn few space travelers feared pain; they'd all found ways to block it. Gray Mourners, the males, were afraid of unprotected sex. Flutterbies?

A Flutterby told Aurora, "Green glop, temperature fifty-one degrees," while the other asked the grads, "How would you live your life if you knew exactly when and how you were to die?"

"I remember an old science-fiction story like that," the boy Willis said. "Martians could see the future, but not the past. Their lives just ran down like a wind-up toy."

Berda said, "I could plan a lot better. My grandmother used to say, 'If I'd known I was going to live this long, I'd have taken better care of myself.'"

Willis asked, "The menu says you can make guacamole?"

"It's already made," Aurora told him.

"Guacamole and Fritos," he said, and she went away.

"There'd be less to be afraid of," the girl said. "Even when you got old, you wouldn't have to worry about falling off a balcony or dodging a bus. The bus either gets you or it doesn't."

"I suggest a different hypothesis," the first Flutterby said. "Presume you know exactly how and when you will die, if you can survive all natural dangers. Your mind will fade first. You will die in ecstasy, and you will be too stupid to know that it's the end for you."

The second said, "The chrysalis form is a deep torpor. What wakes is near mindless. Digestive organs have faded too. There's no motive except survival and mating, and then even those nerves shut down."

The first: "Also you may pause your fate indefinitely. The danger is that all other ways to suffer or die will have more time to find you."

The boy asked, "You're not being hypothetical now, are you?"

"No. This is our fate, but we must still fear all other mischance. Predators, a fall, a misalignment in *Apparent Dischord*'s antimatter containment, could rob us of our destiny. We took this risk gladly in order to see more of the Universe."

Aurora returned pushing a floating tray.

Willis dipped up some guacamole. I hid my grin with a cappuccino mug; but I'd looked first to see he hadn't found the wrong bowl of green glop. He said, "We do the same."

The Flutterbies seemed startled. "What? Do you really?"

"I mean we try to live as long as possible. Whatever's currently killing our old people, we go through a lot of effort to cure it. That always means the next thing in line gets us. It was cancer and Alzheimer's when I was growing up, because we'd cured some other diseases. Elders usually die miserably, and it sometimes takes a long time—"

"There isn't any good way to die," the girl snapped. She looked at the Chirpsithra. "Is there?"

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The Chirp said, "You already know our answer. Some of us are many millions of Earth-orbits old. All sapient beings evade what evolution shaped us for. All meddle with their destiny, even Flutterbies. A Flutterby who succeeds at longevity will not breed. That seems very strange."

"Death comes to all of your kinds, and always unwelcome," the second Flutterby said. "Our death is welcome if we hang on long enough. We've arrested our development, but we took our risk with senses wide open."

The Flutterbies left during a lull in the ongoing ice storm. Afterward, Aurora came to me. "I must resign my post," she said.

"You were listening to them, weren't you?"

"Certainly."

"Does it strike you that they were talking *for* you?"

"Oh, yes," said Aurora. "They could not speak to me, but they could convey arguments in my hearing. Also they brought pheromones from adult Flutterbies. I felt protective and protected, and I heard their arguments. I know what they did to me. I know, but it doesn't matter."

"Pheromones. Doesn't that strike you as unfair?" In fact, the whole jape seemed monstrously unfair.

Aurora said, "We must have adults about us, to protect. Proper pheromones are released into our cabins during flight. If I remain on Earth, I will not have that. I will only have the knowledge that I die without children. But, Rick, their argument cuts both ways. I go to see if they can follow their own logic."

I paid her salary to date, and she went.

Two days later, the Draco Tavern was empty. Corliss went to visit her family in Canada. Jehaneh stayed, of course. With her two passengers—one a visiting sapient bacterium, the other our unborn child—she's grown a bit heavy for travel. And we waited for *Apparent Discord* to leave the Moon.

Instead, a floating cart parked itself outside the array of airlocks. A Chirpsithra came in and got me, the same officer who'd sat at the Wilsonn table.

I looked into the cart at six fat fluffy white bags each about my size, lightly dusted with fluffy white snow, and one growth-arrested Flutterby.

The Chirp said, "We must ask for judgment. May these immigrate?"

"I don't make policy for the UN," I said. "What happened?"

"It may have caught your attention—"

I lost patience. "Half my clientele that day were conspiring to get Aurora back to her berth in *Apparent Discord*. Why?"

The Chirp officer said, "When clients board as a group, we prefer that they remain a group. We do not like to explain how we lost one here, one there. Others of my passengers found it amusing to help rebuild a lapsed . . . family."

"Now you've lost all seven," I said. "Aurora? What happened?"

"You heard their arguments. They were sensible," the remaining Flutterby said, "and I am persuasive. If we—if my mating group were to wait for our return to homeworld, any kind of accident might take us. If we lose even one of seven, our genetic variety might be too sparse. We owe it to our gene line to have our children immediately."

"We? But not you."

"One must remain to teach the children. I may still mate among the next generation."

"Or the one after that. They bought this?"

"Rick, for most of the species I've met, mating has consequences, but not for us. It was not difficult to persuade my family that it is time to mate. My time will come too."

I sighed. I asked, "'Immigrate'?"

The Chirp officer said, "We don't

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have convenient room aboard *Apparent Dischord*. Rick, your planet is wide. A few dozen refugees won't harm you."

"What do they eat?"

"Thank you, Rick, an excellent point. We will learn."

At that point I knew I was stuck. I dropped the word to some news channels before I called any government agencies.

The mating dance swirls above the Draco Tavern, gloriously sharing its colors with the Aurora Borealis. They are all brilliant wings and little torso, more kite than butterfly. They mate while falling. Via movie screens and TV sets it is being seen all over the Earth.

Presently they scatter across the tundra. Chirpsithra researchers have found Siberian plants the immature forms can eat, and scent-marked them so the adults can find them.

I'll have to talk to Aurora about food supplies for future generations. The Siberian tundra isn't exactly lush.■

(EDITOR'S NOTE: Earlier tales of the Draco Tavern include "The Heights" [May 2001], "The Missing Mass" [December 2000], "The Wisdom of Demons" [July/August 2000], and "The Convergence of the Old Mind" [July/August 2002].)

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PHYSICS GOES UNDERGROUND

Major physics research may be heading downward, toward the "inner space" of a very deep mine in South Dakota. The new National Underground Science Laboratory (NUSL) may be created specifically to house and provide shielding for a broad range of cutting-edge low-background physics experiments. Let me explain what's going on.

If you measured the radiation present in our environment with sufficient sensitivity, you would find that the Earth is a rather radioactive place. Radon (half-life 3.82 days), a radioactive inert gas that decays by emitting energetic 8-MeV alpha particles, is produced by natural radium in the Earth's crust. It seeps out of the ground to be inhaled by humans and to collect inside our buildings, in some regions in large enough quantities to become a health hazard. The common element potassium, an important nutrient for all living things (including our bodies), has about 117 atoms of radioactive potassium-40 per million natural potassium atoms. The potassium-40 isotope decays with a half-life of 1.28 billion years, producing energetic electrons and gamma rays. This makes our bodies slightly radioactive so that, for example, we irradiate each other (fortunately at a very low level) when we sleep together. There is also plenty of potassium-40 in the Earth's crust and core. The main reason for the Earth's interior heat—the power source driving volcanic activity and plate tectonics—is the energy liberated by the radioactive decay of potassium-40 and other radionuclides within our planet.

In addition to the Earth's natural radioactivity, we are being continually irradiated by particles from space. Cosmic rays—mainly protons, electrons, and gamma rays, bombard the Earth's upper atmosphere, where they produce muons (or μ leptons). These cosmic muons are energetic charged particles that penetrate through the shielding atmosphere and deep into the Earth's interior. Cosmic muons also make almost every material on the Earth's surface slightly radioactive. In addition, cosmic ray reactions with atmospheric nitrogen and oxygen create carbon-14 (half-life 5,730 years), tritium (half-life 12.3 years), and beryllium-7 (half-life 53 days), all of which collect and decay in organic and other materials.

Our bodies have evolved and adapted in this radioactive environment, and there is little evidence that we are affected, either positively or negatively, by the natural radioactivity in which we live. However, environmental radioactivity and radiation make it difficult to perform radiation-sensitive physics experiments, particularly those in which the effect being measured resembles or is masked by the natural and cosmogenic radioactive background. Such experiments can only be done after reducing the natural radioactive background. The favored way of doing this is to place the experiment deep underground to shield it from cosmic rays and environmental radiation.

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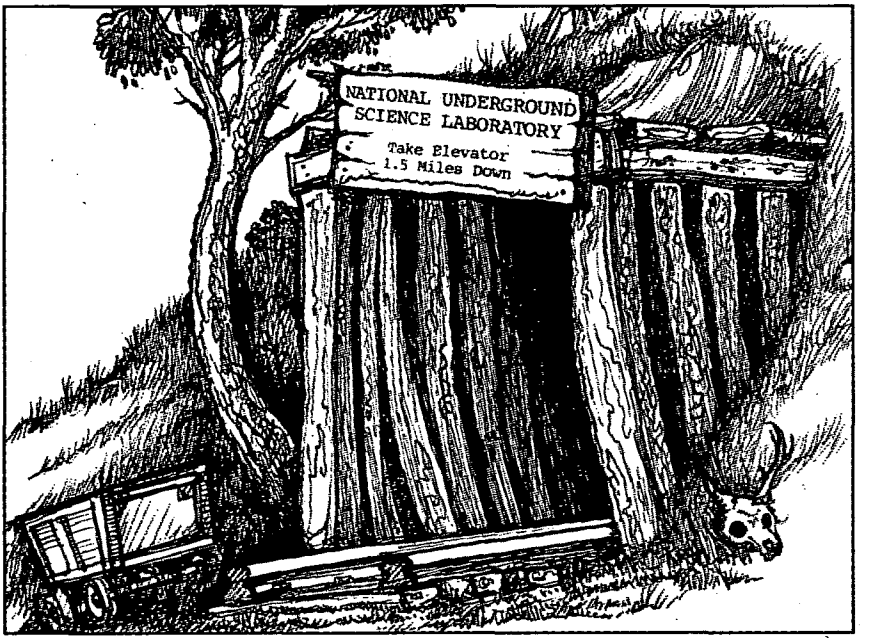

Illustration by Wolf Read

The Homestake gold mine located in Lead (pronounced like the metal), South Dakota has excavations that penetrate over 8,000 feet into the Earth. For many years Homestake has been very productive, both as an active gold mine and as the site of the first solar neutrino experiment, a large chlorine-based detector mounted by Ray Davis and his coworkers in the 1970s. Now the Homestake mine is reaching the end of its useful life as a commercial enterprise, but it may receive new life as a center for cutting-edge physics.

The National Underground Science Laboratory is a major new scientific initiative. It is now in the proposal stage. It would take over operation of the Homestake mine, prevent it from being flooded and abandoned, and make it the home of low-background physics experiments in neutrino detection, studies of rare decay processes, and searches for dark matter particles.

In six of my previous Alternate View columns in *Analog* issues March '86, May '86, December '87, September '92, February '93, and January '99, I described supernova detection, solar and cosmic ray neutrino detection, and dark matter searches, all of which were conducted in underground laboratories. In almost all of these experiments, the measurements were made more difficult by the background radiation from cosmic ray muons. In this column, I'll describe some of the physics projects intended for the NUSL.

Solar Neutrinos—Measurements show that only about $^1/_3$ of the electron neutrinos produced by hydrogen fusion in the Sun reach the Earth. The quantity of neutrinos predicted by the best models of solar fusion reactions is incompatible with the data. Something is wrong. The first evidence of this problem emerged 30 years ago when the neutrino detector in the Homestake Mine went into operation. Recent results from

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the heavy-water-filled SNO neutrino detector located deep in a mine in Sudbury, Ontario, Canada, indicate that the missing neutrinos have been converted into noninteracting neutrino species by a process called "neutrino oscillation." Essentially, as they travel through the medium of the Sun and through the intervening space, the electron neutrinos from solar fusion processes become mu and tau neutrinos, which do not interact with most neutrino detectors.

New solar neutrino detectors built for the NUSL would focus on directly detecting the converted "missing" neutrinos and on measuring the solar neutrino energy spectrum. About 98% of solar neutrinos have energies below 1 million electron volts. Most of the existing detectors have no sensitivity in this energy region, but new detectors are being designed to make measurements there. New detectors would also use "neutral current interactions" to directly detect the mu and tau neutrinos produced in the oscillation process.

Dark Matter—We have come to realize that the ordinary matter of our Universe—the stuff that forms quasars, galaxies, stars, planets, people, atoms, quarks, etc.—is only insignificant fluff, a minor impurity that permeates the real material of the Universe. We have learned in the last few years that about 70% of the mass-energy in the Universe is somehow stored in the vacuum itself as "dark energy," while about 5% is in the form of normal matter. The remaining 25% of the mass-energy is in the form of "cold dark matter," mysterious invisible particles that are known to inhabit the haloes of galaxies.

Astronomers discovered dark matter while using the Doppler-shift technique to measure the velocities of bright stars orbiting distant galaxies and galactic clusters. Roughly speaking, any orbiting object must have a velocity that depends on the square root of the amount of mass within the spherical volume enclosed by its orbit. As the distance (R) of the bright star from the center of the galaxy or cluster increases, it is expected that the star's orbital velocity should first increase in proportion to R, as long as it is at a radius within which the stars of the galaxy are distributed fairly uniformly. When the bright star is at a large radius outside the galaxy, so that the sphere of radius R encloses essentially all of the mass of the galaxy or cluster, the velocity of the star should fall off as the inverse square root of R. Thus, the average mass and mass distribution of a galaxy can be estimated by measuring the velocities of a number of bright stars at various distances from the galactic center.

To the surprise of astronomers, the velocities measured in this way were much larger than expected from a galactic star count, and it was found that the orbital velocity continued to increase with R far beyond the visible radius of the galaxy. This is convincing evidence that the visible mass of a galaxy, even after correcting for nonluminous "brown-dwarf" stars and interstellar gas, is much too small and too localized to account for the observed orbits. The conclusion from this work is that most of the mass of galaxies comes from some mysterious dark matter, which is distributed much more broadly than the visible stars in the galaxies studied. This mystery of the origin of this extra mass has come to be known as "the dark matter problem." It is one of the outstanding unsolved problems of contemporary astrophysics.

The dark matter problem has prompted a close examination of all theoretical possibilities for the missing mass of the universe. Theoretical particle physicists over the years have predicted scores of could-be particles that have never been observed in the laboratory, and many of these have become "dark-matter candidates," particles which, if they existed, might account for the hidden mass of the universe. Among these dark matter candidates are axions, massive neutri-

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nos, and more generally, a whole class of weakly interacting massive particles otherwise known as "WIMPs".

In a typical neutrino or WIMP search, a large dense volume of sensitive detector material must be placed underground in a low-radiation environment. The detector material is chosen so that interaction with the particles of interest, e.g., dark matter WIMPs, produce detectable changes in detector material or directly generate a detectable signal. Up to now, searches for axions and WIMPs have been unsuccessful. The NUSL facility would provide an ideal environment for constructing the next generation of dark matter detectors.

Proton Decay—Quantum mechanics tells us that the black holes themselves are slowly fizzing away to nothingness by boiling off Hawking radiation. But perhaps most devastating of all, we now have reason to consider the possibility that a fundamental building block of the Universe, the proton which is the core of every hydrogen atom, has only a "limited warranty" which may run out in about 10^{34} years or so. With perhaps that half-life, protons (along with all nuclei containing protons) will decay, releasing much energy as they are transformed into lighter particles. The process ends with a positron and some neutrinos and gamma rays replacing the proton.

Every year the Sun may be losing about 10^{18} protons (about 10 micrograms' worth) in this way. This is not much of a loss, but it is irreversible, and it adds up. In 10^{37} years or so, all of the protons in the Universe might be gone. The Universe would then be empty of all complex matter. There would be no galaxies, no stars, no planets, no organisms, no molecules, no atoms, no nuclei. No matter at all would be left except for miscellaneous electrons and positrons seeking a final annihilation and leaving behind only gamma rays.

Why should something as obviously stable as a proton be unstable at its roots? The Buddha gave the reason in about 485 BC: "All composite things decay." And protons may indeed decay because they are composite. We have learned in the past two decades that protons are not fundamental as has been previously supposed, but composite particles made of three quark constituents. It is the interactions and transformations of these quarks that may permit the proton to occasionally decay. The strong, weak and electromagnetic forces are aspects of the same underlying physics, with "bridges" between the forces, and between their manifestation in quarks and leptons. For this reason, a quark can, in principle, decay into leptons, with an accompanying release of energy. If this happens to a quark in a proton, the proton decays. This decay process was first predicted in the 1980s, and several large experiments were mounted to try to observe the phenomenon. These first-generation experiments have not observed proton decay. However, the predicted threshold for detection lies not far below their sensitivity level. If the NUSL project is funded, it is likely that a new proton decay search using the excellent shielding of that facility would be constructed to push down the level where the decay process might be observed.

Supernova Neutrinos—A byproduct of the unsuccessful searches for proton decay in the 1980s was that the large Kamiokande water-filled detector operated by the Japanese was able to observe the neutrons from SN1987A. Several other large proton-decay detectors that might also have observed the neutrinos were off-line at the time. Since that event, the designers of all large water-filled detector experiments have considered their potential as detectors of supernova neutrinos. If the NUSL facility is funded, it is likely that it will provide a permanent site for a supernova neutrino detector, either as a stand-alone detector

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or as a part of a detector that is simultaneously searching for other phenomena.

There are a number of other ideas for experiments at NUSL, but I'll stop here. The National Science Foundation is presently considering this initiative. Watch this column for further developments.

AV Columns On-line: Electronic reprints of over 100 "The Alternate View" columns by John G. Cramer, previously published in *Analog*, are available on-line at: http://www.npl.washington.edu/av.

References

The NUSL Proposal

See the "National Underground Science Laboratory at Homestake" web site, http://mocha.phys.washington.edu/NUSL ■

IN TIMES TO COME

In recent years, as computers have become more and more ubiquitous and interconnected, most of us have become all too familiar with the concept of "computer virus." Many of us have also encountered the idea of "artificial life": computer programs that mimic the behavior of biological systems, in ways up to and including spontaneous evolution (see, for example, Dr. Steven Bratman's fact article in our March issue).

Now . . . in biology, a virus is, at best, an extremely primitive life form. To pursue the analogy, if a computer virus is a very primitive artificial life form, what might evolve from it? And, given that things happen much faster in cyberspace than in biology, what might we do about it? The situation might be something like that in Edward M. Lerner's two-part serial *Survival Instinct*, beginning in our October issue—and set, with uncomfortable appropriateness, in the quite near future!

Randy Asplund will provide the cover for that, and inside our next issue you'll also find stories by such writers as Rajnar Vajra, Michael A. Burstein, Arlan Andrews Sr., Mary A. Turzillo, and Timothy Zahn. The fact article, "The Tell-Tale Brain: The State of Neuroforensics," comes from Kyle Kirkland, Ph.D., a real-life neuroscientist with a science fiction writer's eye for the future.

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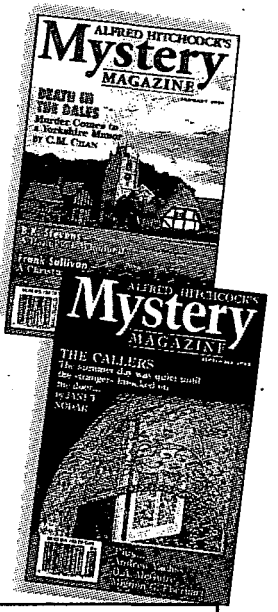

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Bumper Cars

Grey Rollins

Nelson McPhail was bent over so that his rump was all I could see as I entered his shop. The upper half of his body appeared to have been swallowed by an ancient Chevy Camaro; about twenty tons of Detroit-style rust, equipped with an engine bigger than that found in most railroad locomotives. Nelson's an incorrigible tinkerer, cast in the old-fashioned mold. I was afraid to ask what he was up to.

"Did you bring any beer?" he asked, without bothering to pull his head out from under the hood.

"Uh . . . no."

He sighed in exasperation, straightened, and pointed towards the grimy refrigerator against the back wall. "Then at least have the grace to fetch me one of my own, please. Can't you see that I'm about to die of thirst, here?"

I obediently retrieved one for him and, without asking, one for myself. I passed him a bottle, ignoring the possessive look he gave the one in my hand. Watching him for the next ten minutes told me nothing. For all the world, it looked as though he was hand-winding a huge coil of wire just behind the front grille. Why, I couldn't imagine.

"An antenna?" I ventured.

He cast an appraising eye on me. "There's hope for you yet. But don't get fat-headed about it."

Flattery, clearly, is not Nelson's strong suit. For that matter, social skills in general are not part of his world view. I'm used to it. "Okay, I'll bite. You're putting an antenna into the front of an old clunker. Why?"

"Pop the trunk and you'll find one in there, too." He pulled out from under the hood, his expression thoughtful as he decided how to begin. "Okay, I'll try to keep this simple . . ."

Which, I reflected twenty minutes later, was exactly what he had failed to do. I gathered that the antenna transmitted some kind of oscillating electromagnetic field towards the cars in front and behind. The metal in those cars would absorb the transmissions, causing a magnetic field, at which point, the signal from Nelson's car would adjust itself to repel those cars if they got too close. In short, it was sort of an electronic air bag for the entire car.

"But, Nelson, cars are *heavy*. Won't that take a lot of energy?" I protested.

There followed a mind-numbing explanation as to how he had managed to use feedback loops, regenerative braking, and, for all I know, the phases of the Moon to reduce the energy consumption to the point where it was practical.

"But why do it at all?" I asked. "From what you're saying, this will cost hundreds, maybe thousands of dollars."

"I won't bother asking you what the worth of a single human life might be.

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Let's get down to more immediate matters. If it keeps you out of even one fender-bender, that's a couple hundred—maybe even a thousand—there, right?"

"Uh, sure."

"Then we can dispense with those silly five-mile-per-hour bumpers. They never work, anyway, and they're expensive to manufacture. So take those off and you'll save a few hundred more on the purchase price of the car, right?"

I was suspicious of his accounting, but still game. "Well . . . okay."

He stuck his hands in his pockets and proceeded to look insufferably smug. "But I haven't mentioned the *real* ticket. The one that makes it all worthwhile."

"What's that?"

"Tailgaters."

"*Huh?*" Something was wonky with his argument. It took a moment before I caught on. He was going to try to count the safety factor twice. "Nelson, I understand that the car is safer, but—"

An infuriating smile on his face, he raised his finger to make a point. "Not only does it repel, but the closer the other car gets, the more strongly it repels, exactly like trying to force two magnets together. In fact, it's nearly impossible to make another car hit this one. You'd have to be going over forty miles an hour to even scratch the paint."

I was getting frustrated. "Okay, Nelson, I get that part. You've got this great safety device—"

"You still don't get it, do you?" he noted with pity.

Obviously I was missing something, but what?

"Fuel economy," he prompted, as though that was supposed to tell me something.

I shook my head in confusion. "A car like this would be lucky to get ten miles per gallon, and that's with a strong tailwind." I thumped the quarter panel with my fist. "Nelson, there's a *reason* no one drives cars like this any more. You had to drag around a portable oil well, sixteen camels, and a supertanker just to fill up at every third stoplight."

"Would it help if I told you that I drove this car round-trip to Charleston last week on three gallons of gas? That's all. Three gallons! Do the math. That's over seventy miles per gallon. And with the modifications I just made, I should be able to get better than 100 miles per gallon. Just think how much money you could save over the life of the car. More than enough to pay for the gadget. A car equipped with my new invention will actually cost less over the long run!"

"*What?* How?" I managed to stammer.

"You know how bad these morons around here are about tailgating, right?"

"Yeah."

"Well, the next time one gets on your rear bumper, just shift the car into neutral. The repulsive field this car generates will allow you to stay ahead of them, effectively riding on their front bumper. Your engine is idling. Their engine is pushing both their car . . . *and yours.* Ta-dum! Virtually free mileage, courtesy of all those pesky tailgaters!"■

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PROTOCOL

Timothy Zahn

Illustration by Rick McCollum

Most of us like to know the reasons for rules, but sometimes we have to follow them whether we understand or not.

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"I was thinking," Aimee Shondar said casually as she set the last of the breakfast dishes in the drainer, "that I might go to the market this morning."

Her husband Ted lifted his eyes up over the facplate with the look on his face that she'd known would be there. "I was going to fix the garden today," he said, his tone mildly reproving, as if she should have remembered that. "We had a second Stryder come through last night, you know."

"No, I didn't," Aimee said, frowning. Usually she was the first one awake when a Stryder came lumbering across their land in the middle of the night. "What did he hit?"

"Mostly the tomokado area," Ted said, sounding disgusted. "I swear sometimes they deliberately take whatever route will let those size-twenty feet of theirs do the most damage. A lot of it should be salvageable, but it'll take most of the day to replant the vines. I really don't have the time to go to market with you."

"I wasn't asking you to," Aimee said, fighting to keep her voice steady. "I can go by myself."

The look in Ted's face deepened. "We've been through this, Aimee," he reminded her in the patient tone of an adult explaining a difficult concept to a young child. "I don't want you going to the village alone."

"I know that," Aimee said, feeling a quaver trying to nudge its way into her voice. She hated confrontations, hated them with a passion. "But I'm twenty-four years old. It's high time I started learning how to do things on my own."

"So take up knitting," Ted suggested. "Or hydroponics, or supportable architecture. Better yet, come help me in the garden today and we can both go to the market tomorrow."

"But the shoreline traders are coming in today," Aimee protested. "All the best fish will be gone by tomorrow."

With a sigh, Ted laid aside the facplate. "Okay, fine," he said. "I guess I can do the garden tomorrow."

"I already said you don't have to go with me," Aimee said, feeling familiar stirrings of annoyance and frustration. He was patronizing her again. She hated when he patronized her. "I'm perfectly capable of dealing with the Stryders all by myself."

"Really?" he countered, the patient tone starting to fray about the edges. "There's only been one time *I* know about when you were actually alone with them."

Aimee had known the conversation would eventually end up here. All conversations about going into the village alone ended up here. But even knowing that, and expecting it, the comment still hit her in the gut like a Stryder's razordisk. "That's not fair," she insisted, the quaver in her voice into full shake mode now. "Aunt Ruth sneezed during the protocol. It wasn't my fault."

"I never said it was," Ted said calmly. "Look, kiddo, I don't blame you a single scrappy seed. Matter of fact, I've always been rather impressed by the fact that a kid your age didn't panic at what happened, and even managed to get all the way back home by yourself. And past, what, two more Stryders, too?"

Aimee shivered at the memory. After twelve years, she still shivered at the memory. "Three," she corrected him quietly.

"Three," he repeated. "My point is that you can't go through an experience like that without it affecting you. I feel you tense up every time a Stryder lumbers into view, like a rabbit facing a doggerelle. I'm just afraid that—well, look, I'm just afraid, that's all. Okay?"

Aimee sighed deep within her. "I know," she said. "But someday I'm going to have to grow up."

He smiled. "You're already grown up just fine, Aimee," he assured her. "Maybe it's just me who's still feeling traumatized by the past."

"And so I should humor you?"

"Something like that." He stood up,

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brushing the breakfast crumbs off his coveralls. "Give me a couple of minutes to change and we'll go."

The road leading toward the village was more crowded than usual this morning, Aimee thought as they headed out, with both pedestrians and pull carts wending their way between the ruts. Apparently, everyone in the district had fresh fish on their mind. It made her glad she hadn't let Ted talk her into waiting until tomorrow.

"Nice day for a walk, anyway," Ted commented as he steered her around a cart rattling noisily over the rough road. One of the wheels seemed on the verge of falling off, she noticed as they passed it. Too bad, too—the cart itself looked almost new.

But then, what little they had in the way of heavy machinery never seemed to last very long these days. As a girl, Aimee remembered her grandmother spinning grand stories about machines from the colony ship that could create perfectly round, perfectly smooth wheels, as well as other incredible devices that could last for years and years.

But no one had seen anything like that for a long time, and it was unlikely anyone ever would. The Stryders had long since plowed their random Juggernaut paths across and through all the colonists' major manufacturing areas, leaving nothing but rubble behind. Only in the more small-scale areas of electronics manufacture had the colonists been able to maintain anything of the technology they'd brought from Earth.

And it was just as well they'd been able to keep that. Without the language translators and the protocol programs coded into their facplates, the entire colony would long ago have been slaughtered.

"Did you check the list before we left?" Ted asked.

Aimee nodded. "At last report there were four Stryders in the square, with two more—"

"Stryder!" someone ahead of them called.

The knot of people jerked to a halt, a sudden eerie silence ringing in Aimee's ears as the rattle of the carts abruptly ceased. She slid her facplate from its belt pouch, feeling her pulse throbbing at the base of her throat. Somewhere up ahead, Death Incarnate was coming. Coming to snatch the unwary, or the careless, or the foolish. . . .

And then, there he was, just rounding one of the trees ahead to the left of the road: three meters of tall, golden-skinned being, like a mythological Greek god impossibly come to life. He was walking more or less toward the group of humans, his path cutting diagonally across the road ahead of them.

Beside her, Ted lifted his plate chest high. "Fifty meters ahead, angling inward thirty degrees left to right," he murmured rapidly toward the plate. All around them, Aimee could hear others muttering into their own plates.

And even with her stomach trying to do gymnastic maneuvers around her spleen, she found herself smiling tightly to herself. This one, at least, was a no-brainer. She'd done this protocol so many times she could practically quote it. *Stand still, head bowed to look one meter in front of you, hands folded in front of your chest—*

"Stand still, head bowed to look at the ground one meter in front of your feet, with your hands folded in front of your chest," she heard Ted's plate give the protocol for this kind of encounter. "Holding objects in your folded hands is acceptable. If he changes direction to approach at less than ten degrees, drop to your knees as soon as he comes within your peripheral vision, head still bowed. Resume activities when you can no longer see him. If he continues or increases his angle, maintain position. Resume activities when you can no longer hear his footsteps."

All around her, Aimee could hear the protocol message being repeated from

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another thirty plates. For her part, she had already bowed her head, folding her hands around her plate at her chest. Straining against the tops of her eyelids so that she could see if the Stryder changed direction toward her, she tried to ignore the tension quivering through her muscles.

Did all the people around her have that same quivering, she wondered? Certainly they all had cause to. The Stryders had killed over a quarter of the colonists in their first two months on the ground, and had probably killed one a week in the thirty years since then. Everyone knew someone who had died suddenly and violently at the edge of a razordisk for making some mistake in the protocol. She was hardly alone on that score.

And yet somehow, all the rest of them managed to get through the day just fine. Maybe Ted was right, she thought distantly. Maybe she just didn't have the emotional strength to face the Stryders alone.

The thudding footsteps were getting closer. Aimee tensed a little harder; and then the footsteps were past and heading back into the forest to the right. She took a deep breath, let it out slowly. The footsteps faded into the forest sounds—

"All clear," someone on that edge called softly.

There was a general rustling as everyone relaxed, coming out of their stiff bows and taking a few deep breaths of their own. A murmur of conversation rippled through the crowd, and here and there Aimee heard a nervous giggle or a mother calming her frightened children. With a multitonal group squeak, the carts started up again, and the crowd shambled back on its way.

"Why didn't you check the protocol?" Ted asked, his voice tight.

"I didn't need to," Aimee told him. "Most contacts are in that ninety-to-ten-degree approach angle. I know that one by heart."

"I don't care if you've got it tattooed on your retinas," Ted growled. "You don't play like that with Stryders. Ever."

"I'm not a child, Ted," Aimee shot back in a low voice, feeling heat rising into her cheeks. To be lectured that way in the privacy of her own home was bad enough; but have it thrown into her face in public was humiliating in the extreme. "I can take care of myself."

"Then prove it," he countered, not bothering to lower his voice. "And you can start by calling up the protocol yourself instead of relying on someone else to do it for you."

Clenching her teeth, Aimee kept her eyes on the back of the woman walking ahead of them. "Whatever you say."

The rest of the trip—aside from the creaking of the carts, the buzz of conversation from the rest of the crowd, and the rustlings of the forest—was very quiet.

The settlement of Venture had once been envisioned as the first and possibly greatest city of the new colony, a sprawling metropolis filling the land between the forest and the ocean shore thirty miles to the east, with the mysterious Great White Pyramid as the center of a huge park within its borders. But with the discovery of the Stryders, all such grandiose plans had long ago faded into dust. Small villages were about as extensive as human habitation got here, and even that was sometimes pushing their luck. The more decentralized the populace, the better.

Still, even a small village was a treat after the isolation of the forest. Aimee took deep breaths as they passed the outer rings of houses and shops and continued inward, drinking in the aromas of cooking and baking and commerce and people. It was like waking from a dream, she always thought at this point. A reminder of what it was to be human.

"Two more have come in," Ted grunted from beside her, studying his plate. "We'll probably run into at least one of them."

"That's okay," Aimee said, looking

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around at the various merchants opening up their shops and trying to ignore the butterflies testing their wings in her stomach. "I'm ready."

"And if and when it happens, you check the protocol," he said tartly. "I don't see any fish here. The dealers must be somewhere on the other side of the Sanctuary."

"Yes, they're probably on the east side, near the butchers," Aimee agreed as they started to angle off to the right. "Most of the other people seem to be heading that direction—"

"Stryder!" the call drifted back.

Everyone stopped dead in their tracks. "Where?" Aimee heard a man growl. "I don't see anything."

"That way!" a young girl answered, pointing to the left, her voice a mixture of excitement and dread. "I can hear him!"

Just about twelve years old, Aimee noted with a quiet shudder as she gazed at the girl's profile. The same age she herself had been when that Stryder had cut down Aunt Ruth beside her.

At her side now, Ted was nudging her urgently with his elbow. Pushing back the memories, she pulled out her plate.

And then, from the direction the girl was pointing, the Stryder appeared from behind a tree. He pushed past the side of one of the booths, his bulk bending back the memory plastic and eliciting a soft crunch from something inside, and headed straight toward them.

The butterflies in Aimee's stomach took flight as she lifted the plate to her lips. "Fifty meters to the left, coming straight toward me," she said, her lips feeling cold and dry. "He just pushed past a booth, probably breaking something inside."

"Go down on your right knee, continuing to face forward, leaving your left knee bent at a ninety-degree angle," the plate instructed her. "Put your left hand on your left knee, palm resting on the kneecap, fingers pointed down along the shin. Set your plate down on the ground and then put your right hand across the back of your left, elbow pointing forward and bent at a ninety-degree angle, fingers pointed straight out toward the Stryder. Lower your head to look at your crossed hands."

She did as instructed. Her right arm wasn't quite long enough to make a precise ninety-degree angle, and she had to lean her shoulder forward a little to compensate. Peripherally, she could see everyone nearby following suit as she gazed at her hands. Those farther away, of course, would be doing the protocol for a ten-to-ninety-degree sideways approach.

What did it all mean? After thirty years, no one still had an answer to that question. The Stryders didn't even seem to notice the humans scurrying around their feet, at least as long as they obeyed the strange rules of the protocol: They couldn't be communicated or reasoned with; they couldn't be deflected or lured or frightened away from the complex paths they wove through human-occupied land; and they couldn't be killed, at least not with any weapon the colonists had ever been able to bring against them.

They were like berserkers or Juggernauts, living in a secret self-contained world within their own minds, creating their secret rules for others to follow. Only when the protocol was broken did they come out of those shells, and then only to kill with instant and emotionless efficiency. No one knew where they lived, if they indeed lived in any particular place or society. The colony ship's sensors hadn't spotted any such groupings on its way in, and the handful of brave or rash souls who had tried to track the Stryders back through the forest had never been heard from again.

Every possible approach to communication had been attempted, to no avail. The colonists had tried human speech, both at normal pitch and as shifted to other segments of the auditory spectrum. Lights had been tried, and mathe-

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matical and geometric symbols, and odors and tastes and Morse and Jartrac codes. Kla'ka Four, the nearest thing to a general trade language that the archaeologists had ever found in this region of space, had had no more impact with the Stryders than any of the Earth languages had.

Someone had even talked the colony's governors into letting her try an interpretive dance. That had garnered the same nonresults as everything else, except that the dancers had died even faster.

The Stryder was coming closer now, his slow, steady footsteps shaking the ground and sending shivers through Aimee's knee. She kept her eyes down, double-checking the angle of her elbow and wondering if the crowd was too tightly packed for the Stryder to get through without stepping on someone. As far as she knew, that had never happened, but there was always a first time. Out of the corner of her eye, she could see the man directly in front of her fidget slightly, possibly wondering the same thing. *Hold still*, she pleaded silently with him as he fidgeted again. The approaching Stryder was well within razordisk range, and she had no desire to see the man fidget his way to a bloody death. The footsteps were practically on top of her—

And suddenly, the air filled with a sound that froze her blood and wrenched her back a dozen years to that horrible day with Aunt Ruth. A sound like the moan of a wounded wolfbat.

The Stryder had activated his razordisk.

A scream bubbled up in Aimee's throat; desperately, viciously, she forced it down. Screaming wasn't part of the protocol.

The nervous man in front of her apparently wasn't as strong or as self-controlled as she was. He gave another twitch at the sound, the worst one yet.

Aimee's breath was coming in short, painful bursts now. No doubt; the razordisk was for him. She wanted to squeeze her eyes shut, to block out her view of his back before the silvery death cut through his heart and lungs and spine and left him broken on the roadway.

But shutting her eyes wasn't part of the protocol, either. Instead, she focused her attention on the back of her own hand, counting the veins and praying that for once a Stryder would change his mind and go away without killing someone—

The wolfbat moan changed pitch; and with a flash of reflected sunlight the razordisk shot past her forehead, snapping back in its return flight half a racing heartbeat later. A burst of bright red erupted across her vision, obscenely brilliant in the morning sunlight.

And without even a last gasp, Ted toppled over and collapsed into a spreading pool of his own blood.

The footsteps resumed their plodding, and the Stryder passed through the rest of the crowd, without so much as stepping on an outstretched toe.

The Sanctuary was a slightly irregular circle, perhaps ten meters across, in the center of the village square and bordered by a hedge of meter-high bushes dotted with delicate orange-colored flowers. For some unknown reason, the Stryders always avoided the ring, as well as ignoring everything that went on inside it. Anyone who wanted to relax and not have to think about Stryders for a few minutes could step through one of the three narrow gaps into the circle and sit down on one of the benches set around the inside.

The time limit for most people was ten minutes before they had to give up their place to someone else and move on. For someone like Aimee, there was no such restriction.

She was sitting in the shady side of the circle, staring down at the ground, when a pair of booted feet suddenly intruded. "Here," a man's voice said,

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sounding like it was coming from far away.

She looked up, the haze of unreality glazed across her eyes parting just far enough to show an earnest young face gazing down at her from above a stiff uniform collar. "What?" she asked. Her voice sounded as distant as his.

"I brought you something to drink," he said. "It'll help you feel better."

She lowered her eyes from his face, down past the policeman's badge pinned to his uniform jacket, and focused at last on the cup in his hand. "No, thank you," she murmured.

He seemed to hesitate, then moved to the bench and sat down beside her. "I'm sorry for your loss, Mrs. Shondar," he said quietly. "I wish there was something I could say or do to help."

"Thank you," she said mechanically, still staring at the cup in his hand. "I don't . . . what did he do wrong?"

"I don't know," the patrolman said. "Did you happen to notice anything?"

Aimee shook her head, tearing her eyes away from the cup to look across at the far side of the hedge and the orange flowers. Once, she knew, there had been a plan to plant this species of hedge around the whole colony, giving them permanent protection against the Stryders. But everywhere else that it was planted, the flowers came out yellow, and the Stryders trampled them into the ground as uncaringly as they did tomokado vines. "I saw the man in front of me twitching," she said. "I wasn't facing toward Ted."

"No, of course not," the patrolman agreed. "Well, Sergeant Royce is running the facplates' records now. We'll know soon enough what happened."

"But how could he have done anything wrong?" Aimee protested. "It was all right there. He knew how to follow the protocol."

"I know," the policeman said. "But sometimes it's such a small and subtle mistake that you don't even notice it until it's too late. You're sure you didn't see anything?"

"No," Aimee said, frowning up at him. Granted that it had been twelve years since the last time she'd gone through this, the questions weren't going at all the way she remembered them. "I'm sorry. What was your name again?"

"Patrolman Ricardo Clay," he told her, not taking offense even though she had the vague feeling he'd given her his name at least twice already. "The reason I ask, Mrs. Shondar, is that we've already talked to most of the people who were closest to you. None of them has any recollection of your husband breaking protocol, either."

"But that's impossible," Aimee said. "If he follows protocol, they have to let him live. Don't they?"

Clay's lip twitched. "As far as we can tell, they don't actually *have* to do anything," he reminded her soberly. "But up to now, yes, as long as a person stayed within protocol, he was okay."

"What do you mean, 'up to now'?" Aimee asked. "Has something changed?"

"I don't know." Clay's eyes shifted over her shoulder. "Maybe we're about to find out."

Aimee looked behind her. An older patrolman was coming toward them, sergeant's braid glittering on his shoulder, her facplate gripped in his right hand. "Mrs. Shondar," he greeted her as he stepped up beside Clay. "I'm Sergeant Royce. We've just done a complete analysis of yours and your husband's plate records."

His eyebrows lifted slightly. "And we'll be damned if we can find anything he did to break protocol."

Aimee's skin began to prickle. There'd been just the slightest emphasis on the word *he*. "What are you suggesting?" she asked. "If he didn't break protocol, why is he dead?"

"As I said, we really don't know," Royce said, an odd glint in his eye. "Though it's possible we might have missed something. Your plate doesn't have a very clear view of the event;

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we're still analyzing your husband's."

"But if you didn't miss anything?"

Royce was still eyeing her strangely. "Then we may have something new cropping up," he said. "Maybe some little nuance we haven't gleaned from the Pyramid record yet."

Automatically, Aimee's eyes drifted over his shoulder to the slivers of white that could be seen through the surrounding trees. The Great White Pyramid, with its detailed listing of the protocol set out in five languages—Kla'ka Four among them—had been the colony's salvation after all the attempts to communicate with or destroy the Stryders had failed. "But that's impossible," she said. "Isn't it? The archaeologists and linguists have been over it a thousand times. How could they possibly have missed anything?"

"I don't know," Royce said evenly. "But I'm sure you agree that anything's possible." He paused, just a fraction of a second too long. "By the way, have you ever gone out and looked at the Pyramid yourself?"

"My aunt took me to see it once when I was ten," she told him slowly. "I haven't been there since."

"Uh-huh," Royce said. "That was your Aunt Lydia, wasn't it? The one who was pretty good at reading Kla'ka Four?"

Aimee looked at Patrolman Clay, who was in turn peering up at Sergeant Royce. The younger man looked as confused as she felt. "She read me a few lines," she acknowledged. "Mostly parts of the protocol I already knew."

"'Mostly'?" Royce echoed.

"All right, it was *all* parts of the protocol I already knew," Aimee said, anger beginning to seep into the numbness. What was he trying to say, anyway? "Is that better?"

"If it's the truth," Royce said, his expression not changing in the slightest. "Tell me, Mrs. Shondar: how have you been getting along with your husband?"

The wisps of anger vanished into something very cold. "What do you mean?" she asked carefully.

"What I mean is that several of the people we interviewed mentioned that the two of you had an argument on the way to Venture this morning," Royce said. "What was it about?"

Aimee swallowed. "That was a private matter between me and my husband."

"Maybe," Royce said, his eyes hardening. "Maybe not. This is a death investigation; and in death investigations we have a lot of latitude as to what gets to stay private and what doesn't."

Clay cleared his throat. "Excuse me, sir, but I'm a little confused. This is a simple Stryder death, not a homicide."

"Is it?" Royce countered. "Again, maybe or maybe not. You haven't answered my question, Mrs. Shondar."

It took Aimee a moment to even remember what the question was. "Ted was angry because I did the protocol from memory instead of calling it up on the plate," she said. "I told him I knew that particular one by heart; he didn't think it was a good idea to do it that way."

"He was right about that, actually," Clay murmured. "Two-thirds of all Stryder killings are a result of people getting complacent or careless."

"I wasn't getting complacent," Aimee snapped. "If anyone out there this morning knew what messing up the protocol would mean, it was me."

"Yes, of course," Clay said hastily. "I didn't mean to suggest you were taking it lightly."

"Still, as long as we're on the subject," Royce put in, "how about telling us what your relationship was like with your Aunt Ruth?"

Aimee felt the memory of that day tearing through her stomach. "What kind of a question is that?" she snarled, her voice starting to shake. "I loved my aunt."

"Just like you loved your husband?" Royce asked pointedly. "Tell me: did you have a similar argument with her that morning? Possibly on the same subject

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of being treated like a child?"

Royce's face was beginning to swim in front of her eyes. "I don't know what you're talking about," she said, her voice sounding like it was coming out of a deep well. The whole world was starting to swim now. . . .

She awoke with a start, to find herself lying on the bench where she'd been sitting. Directly above her, the sky had turned a dark shade of purple with tinges of red and yellow in it.

What in the *world*. . . ?

She started to lift her head, instantly regretting the decision as her neck abruptly screamed from a dozen locales at the hasty movement. Carefully, stifling a moan, she eased it back down again.

"Ah—you're awake," a voice came from behind her.

More carefully this time, Aimee lifted her head and turned it around. Patrolman Clay was walking across the Sanctuary ring toward her, his shirt sleeves rippling in the evening breeze.

The *evening* breeze?

She looked around again. It was evening, all right, with the brilliant colors of sunset peeking through the trees to the west. "What happened?" she asked.

"You fainted," Clay explained, coming to her side and helping her sit up. "We called Dr. Bhahatya, who said it would be best to let you sleep, so we had him give you an injection."

"Was that your idea?" Aimee asked, carefully stretching stiff arms. "Calling the doctor, I mean."

Clay shrugged slightly. "Mostly."

"Sergeant Royce won't be very happy about that," she warned bitterly. "Interrupting his interrogation that way."

Clay waved a hand casually. "He'll get over it."

"I don't think so." Aimee closed her eyes briefly. "He thinks I murdered my husband, doesn't he?"

She opened her eyes in time to see Clay purse his lips. "You have to admit it's an intriguing idea," he said. "If you could somehow find a way to make someone break protocol—without also doing it yourself, of course—you'd have a way to commit the perfect murder. In front of witnesses, too."

A lump rose into Aimee's throat. "I loved my husband, Patrolman Clay," she said. "I really did. I didn't want him dead. I didn't want Aunt Ruth dead, either. Doesn't anyone believe me?"

"I believe you," Clay said quietly. "But I don't believe what happened today is just an unexplained accident, either. *Something* happened to cause that Stryder to attack."

"But what?" Aimee asked. "I didn't do anything. I *know* I didn't."

"Maybe it was something subtle," Clay suggested. "Something so small that you didn't even notice it. Or maybe it's something else, some new layer in the protocol that we haven't figured out yet."

"Like what?" she asked.

"I don't know," Clay said. "Maybe it's something having to do with you personally. You were, what, twelve years old when your aunt was killed?"

"That's right."

"And it's been another twelve years since then," Clay continued. "Maybe the Stryders are celebrating an anniversary or something."

Aimee winced. "That's a horrible thought."

"I agree," Clay said. "And personally, I don't believe it for a second. But until we figure out what happened, we can't afford to dismiss any of the possibilities."

"Including the possibility that I deliberately murdered them?"

Clay started to speak, but apparently thought better of it. "Look, it's going to be dark soon. Why don't you stay in the Sanctuary tonight where you'll be safe, and we can talk more in the morning."

Aimee's first reaction was to insist that she wasn't afraid of the dark, and that she was perfectly capable of traveling.

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But the reaction was pure pride, and her pride had already caused enough damage for one day. Besides, she really didn't feel like a walk all alone in the dark. "All right," she said.

"Good." Almost shyly, he smiled at her. "I've got to get back to work—I'm on evening patrol tonight. I'll leave you my coat, though, in case you get cold."

She looked down, noticing for the first time that his jacket was neatly folded right where her head had been lying on the bench. Apparently, it had already served duty as her pillow. "Thank you," she said.

"No problem," he said, moving toward one of the gaps in the hedge. "I'll look in on you a little later." He paused at the gap, glanced around for any signs of Stryders, then strode out into the gathering dusk.

For a long time, Aimee sat on the bench, watching the sky fade into purple and then into starlit black. The businesses around the square were long since closed, but there were enough lights from nearby residences to throw a faint glow over the area.

And with the ghostly light washing over her, she gazed at the stars and listened to the night breezes whispering through the trees.

And tried to think.

What had she done? Because she *had* done something. Everyone agreed on that, even those like Patrolman Clay who didn't think she'd done anything on purpose. Somehow, something she'd done had caused a Stryder to kill her husband.

But how? And why? Could she have been angrier at him than she'd realized? Some kind of deep or lingering anger that she didn't even know was there?

No. She'd loved her husband. Hadn't she? Of course she had. And she'd loved Aunt Ruth, too. The older woman had irritated her sometimes, but *everyone* had irritated her sometimes back then. Part of being twelve, she supposed.

But if somehow her subconscious had latched onto that irritation and figured out a way to break protocol for someone else . . .

She shook her head decisively. No. Aunt Ruth had sneezed. That sneeze, and the resulting rearrangement of head and torso and arms, was what had broken protocol and gotten her killed. These were two entirely different cases, despite Sergeant Royce's efforts to link them.

What about Patrolman Clay's theory? Could it be a matter of who she was, rather than something she'd done? Had the Stryders somehow gotten it into their heads that every twelve years someone standing or kneeling or crouching beside her should die?

But no. That didn't make any sense.

But then, what sense did the protocol make in the first place? Why impose such arbitrary rules of conduct on helpless people, with death as the punishment for every single infraction?

And not just on human beings. Whoever had set up the Pyramid with its five languages had clearly been trying to make sure that at least five different species would be able to learn and follow the protocol. Apparently, the Stryders played this same vicious game with everyone who happened by.

Except that this particular group of playmates weren't going to simply play the Stryders' game for awhile and then move on. If Earth hadn't sent a follow-up ship by now, they never would. The colonists were trapped here. Trapped on this otherwise lovely and bountiful world with the Stryders and their protocol.

And if there was something new happening with that protocol, they weren't going to be living here much longer.

So what in heaven's name had she *done?*

Her plate was lying on the bench near Patrolman Clay's folded jacket. Slowly, reluctantly, she reached over and picked it up. The record of Ted's death was in there, recorded in all its horrifying de-

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tail. The thought of watching it . . .

It's been another twelve years since then, Patrolman Clay had suggested. *Maybe the Stryders are celebrating an anniversary.*

She took a deep breath. The thought of living through Ted's death again made her feel violently ill. But she had to know. Bracing herself, she keyed for the record.

It was as bad as she'd expected. Worse. With the position the plate had been in, she could only see Ted's left side, but that was enough to send her stomach into a fresh knot. She watched and listened as she and Ted went into the protocol positions; watched and listened as the Stryder clumped toward them; watched and listened at that horrible moment when the razordisk whipped past overhead, cutting into Ted's side with a splash of red and then returning like a deadly yo-yo to its owner. She heard herself give a strangled gasp as Ted fell to the ground; saw the image turn half red as a stray drop of blood landed on the recording lens, partially obscuring it.

And she saw the Stryder pass by, looming overhead like a giant tree as he made his unconcerned way past his victim. The footsteps faded into the distance, and she heard herself begin to moan. . . .

With a stabbing jerk of her finger, she shut off the record, squeezing her eyes tightly shut as if cutting off the images would somehow destroy the memory.

But at the same time, she knew she couldn't afford to lose any bit of that memory. Not yet. Sergeant Royce had said Ted's plate didn't show exactly what had happened, either. If they were going to figure out how he had broken protocol, it was going to be up to her to figure it out.

Slowly, tiredly, she opened her eyes.

To find a Stryder standing directly across the Sanctuary ring, just outside the hedge.

Staring at her.

Her heart seemed to freeze in her chest. No one knew how exactly the hedge protected them against the Stryders. One theory was that they liked the orange flowers so much they didn't want to risk damaging them. Another was that the delicate aroma somehow obscured their vision, so that they literally couldn't see what was happening inside the hedge.

But all anyone really knew was that, up to now, the hedge had kept the Stryders away from you.

But then, up to now, following the protocol had done the same thing.

Up to now.

The Stryder was still standing there. Still staring at her. Aimee stared back, holding as still as she could, Ted's image of a rabbit facing a doggerelle flashing through her mind. No Stryder had ever stared at her that way before. For that matter, she couldn't recall ever seeing a Stryder even standing still before. Even when they killed, they never so much as broke stride.

And yet, this one was standing. *And* staring.

Was it the same Stryder who had killed Ted? There were supposed to be subtle differences between them, but Aimee had never been able to tell one Stryder from another. Could Sergeant Royce have been right about her somehow instigating the attack? Had the Stryder later realized that, and decided that Aimee deserved to die, too?

She realized she had stopped breathing. Slowly, carefully, she inhaled, feeling terribly alone. If only someone was here with her; Patrolman Clay, or even Sergeant Royce. If the Stryder wanted her, of course, there was nothing either of them could do. But suddenly she was terrified at the thought of dying without another human present to say good-bye to.

The Stryder still hadn't moved, and she found herself wondering bleakly what he was waiting for. The hedge itself was certainly no physical barrier,

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and his razordisk probably had enough range to get her here at the far side anyway. What was he waiting for?

And then, suddenly, something inside her snapped. If this was her night to die, she wasn't going to take it hiding beneath the flowers in a corner like a frightened rabbit. Standing up, stuffing her facplate back into its pouch, she started across the Sanctuary ring toward the Stryder.

With every step, she expected him to raise his right arm and send the razordisk nestled beneath it flashing toward her, to cut through her heart and lungs and to quiet forever the agonizing memory of Ted's death. But still he stood there, unmoving, as she approached.

Until finally she stood just inside the hedge from him.

For a long moment she gazed silently at him, staring up into his face. Every variation of the protocol she'd ever heard made you bow down before a Stryder ever got this close; and though she'd seen plenty of telephoto pictures of them, she realized suddenly that no picture or video had ever really done them justice.

It was an old face. A face that had seen many things; a face that somehow reflected deep wanderings in secret thoughts and paths. Even in the darkness his eyes were bright as he stared down at her, and Aimee could feel a sense of eminence and mystery and serenity hovering around him. Like a Greek god, she'd often thought, or the wise mentor to humanity that so many people had longed for over the centuries.

Only these mentors killed on a whim.

She took a deep breath. If this was indeed her night to die, then nothing she could do could stop it. But perhaps she could at least voice her objections to this insanity before that happened. "Why?" she asked, her voice sounding harsh and crowlike against the Stryder's innate grandeur. "Why did you kill him?"

The Stryder seemed to consider that. Or maybe he was just ignoring her. The first colonists had tried to talk to the Stryders too, she remembered. All it had gotten them was killed.

And then, abruptly yet smoothly, he lifted his arm.

Aimee flinched back, her eyes dropping to the razordisk against his forearm. But the arm stopped, and there was no wolfbat moan, and the weapon didn't move. Slowly, she let her gaze travel down the arm to the huge hand reaching over the hedge toward her. The hand was cupped, palm up, as if he wanted something.

Aimee swallowed. What did he want? In another human, the gesture might have indicated that she was to take his hand, as if he was preparing to lead her somewhere. But somehow, she sensed that wasn't it.

And then she noticed that not all the fingers were cupped. One of them was stretched out straight—almost curved under, in fact—pointing at her belt pouch.

At her facplate.

"My plate?" she asked, reaching carefully toward it. "Is that what you want?"

The Stryder didn't move or speak. Carefully, wondering if she was in fact reading him correctly, she began working the plate free. Was he trying to tell her there was a protocol for this kind of face-to-face meeting? She couldn't imagine there being such a thing; and even if there was, no Stryder ever gave out hints like that, even in mime. Their entire range of responses was either to ignore or to kill.

Still, this one was already doing things she'd never heard of from a Stryder. Maybe, for once, one was actually giving a human the benefit of the doubt. She got the plate out and lifted it to her lips—

And with a smooth motion, the Stryder turned his cupped hand over and plucked it from her grasp. Turning, he strode away across the square and disap-

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peared around a shop.

Aimee watched him go, her body seeming to sag inside her skin. So that was it. No benefit of the doubt; no communication; no nothing. The Stryder had indeed realized he'd made a mistake earlier, and this was his way of rectifying it.

Because without a plate, she was as good as dead. Her mind flicked back to that day with Aunt Ruth, and how she'd had to use her plate to pull up the protocol three more times before she was able to make it home. By taking her plate, the Stryder was effectively condemning her to death the minute she left the safety of the Sanctuary.

Slowly, she turned and headed back across the circle. *Relax*, she tried to tell herself. *Just stay here until Patrolman Clay gets back, and he'll get you a new plate.*

But that would be at best a temporary fix. If the Stryders could take one plate away from her, they could take the next one away, and the next one, and the next, until at some point she would be caught out in the open with a Stryder and no idea what the protocol was to keep him away.

And even in her despair, she could see the irony in it. Sergeant Royce had all but accused her of getting a Stryder to kill her husband for her. Now, by taking her plate, this Stryder was doing that exact same thing to her.

She reached the bench where Patrolman Clay's jacket lay and sat down beside it. All sorts of desperate plans and ideas had chased each other through her mind on the short walk across the circle, but she knew there was no point in trying any of them tonight. In the morning, perhaps, she would be able to think more clearly.

Assuming, of course, the Stryders didn't come for her before then.

But if they did, there was still nothing she could do tonight. And at the moment she was too drained of emotion to even worry about it. Stretching out on the bench, pillowing her head on the folded jacket, she drifted off to sleep.

"Mrs. Shondar? Aimee?"

She woke with a start, muscles jerking with sudden terror. But it wasn't one of the Stryders who had haunted her dreams crouching over her, just Patrolman Clay. In the pink predawn light she could see the lines of tension were back in his face. "Yes, I'm awake," she said, her mouth feeling dry. "What is it?"

"Come on," he said, taking her hand and urging her upward. "You need to see this."

Abruptly, the memories of the night flooded back. "I can't," she protested, even as she swung her legs over the side of the bench. "He took my plate."

"Who, Sergeant Royce?" Clay asked, frowning.

Aimee shook her head. "One of the Stryders."

Clay's eyes widened. "One of the *Stryders?* But . . ."

He inhaled sharply, his face abruptly changing. "Oh, my God," he said softly. "So *that's* it. Come on, you *definitely* need to see this."

There was something in his voice that stifled all further protest. Standing up, she let him lead her across the Sanctuary circle.

There, lying on his back in the square a few meters outside the hedge, was a Stryder.

Dead.

Aimee caught her breath. "What—"

"He was there when I got back a few minutes ago," Clay told her. "We can check your husband's plate record, but I'm betting he's the one who killed him."

He gestured toward the Stryder. "Which must be why the other Stryder took your plate. So he could figure out who he was, too."

"I don't understand," Aimee said, unable to take her eyes off the body. She was so accustomed to thinking of the Stryders as messengers of death that it

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was a shock to see one lying there dead himself. "What's he doing here?"

"Don't you see?" Clay said quietly. "He killed your husband. Only he shouldn't have, because your husband hadn't done anything wrong."

Aimee turned to him, sudden understanding twisting through her heart. "Are you saying . . . ?"

"Your husband didn't break protocol, Aimee," Clay said. "Neither did you. It was the *Stryder* who broke it."

His lips compressed briefly. "And even for Stryders, I guess, the penalty for breaking protocol is death."

Aimee looked out at the body again, a dark and depressing confusion tugging at her emotions. "They're trapped by it too," she said quietly. "For all their cold-blooded killing, they're as trapped by the protocol as we are."

"So it seems," Clay agreed. "Well. Come on, let's get you a new plate, and I'll escort you home."

"It's not that easy," Aimee said, looking at him again. "What about him?"

Clay frowned. "What do you mean? What about him?"

"What do we do with the body?" Aimee asked. "Do we leave it there for the Stryders to collect? Or do we bury it, or build a funeral pyre, or walk in a circle around it with our heads bowed, or what? What's the protocol for this?"

The tension lines were back in Clay's face. "Oh, my God," he breathed. "We'd better get someone out to the Pyramid. And fast." ■

It is not the oath that makes us believe the man but the man the oath.

—Aeschylus

Vision is the art of seeing the invisible.

—Jonathan Swift

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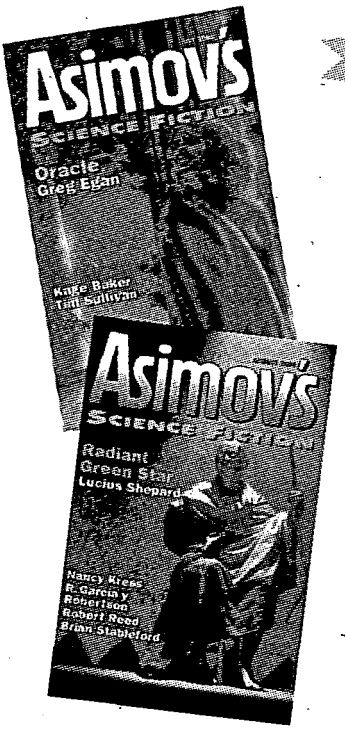

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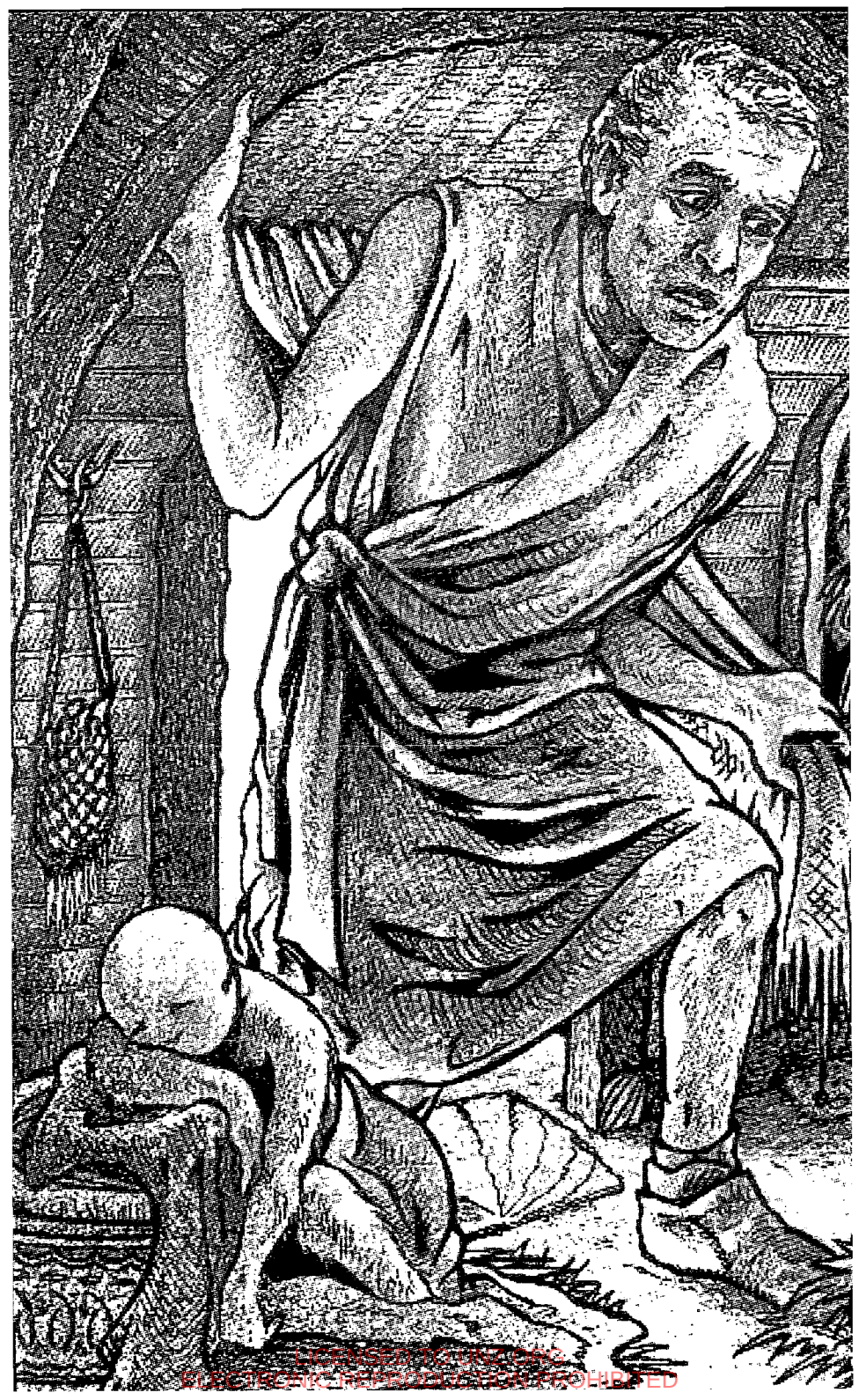

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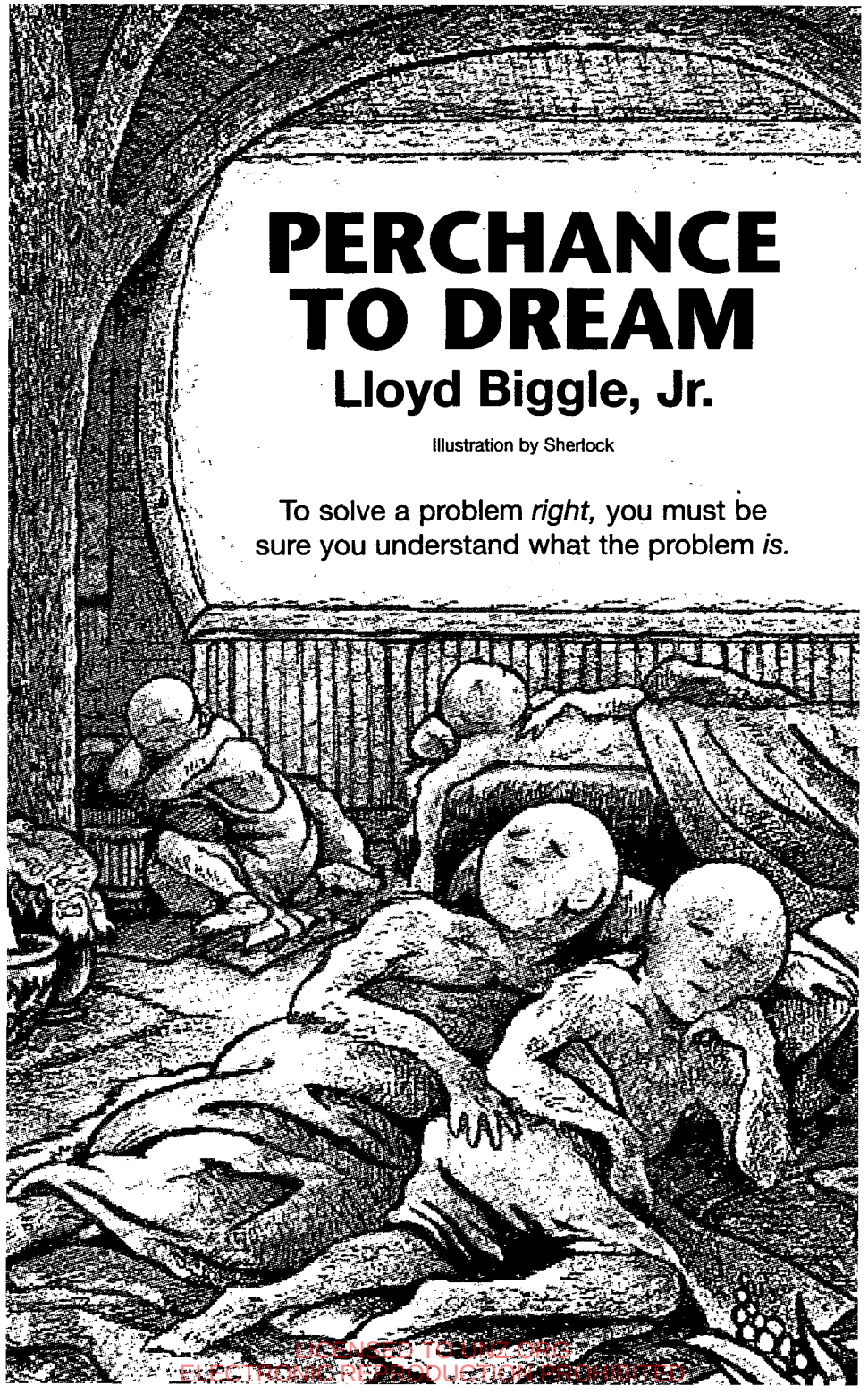

PERCHANCE TO DREAM

Lloyd Biggle, Jr.

Illustration by Sherlock

To solve a problem *right,* you must be sure you understand what the problem *is.*

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Most of the officers seated around the conference table were elderly, and they were long accustomed both to their high prerogatives and their exacting responsibilities. They had interrupted busy schedules and journeyed far for no other reason than to sit at this table and watch the teloid projection that was filling one end of the long room. They dutifully gave it their full attention; at the same time, their attitudes left no doubt that this had better be worth all the trouble they were taking—or else.

The projection showed a seashore, lovely in the soft light of early morning, with oddly blunted fishing boats drawn up on the beach. In the foreground, a cluster of small houses of clay-daubed wattle loomed dimly through a thick haze of smoke. The village's smokehouse stood further up the shore just above the village; the wind was offshore, and the smokehouse fumes had enveloped the village.

The cameras should have recorded a typical village scene with children at play, females preparing meals, and males going about their varied chores; but an evil spell had frozen the villagers into immobility.

They lay as if bewitched. A female carrying water from a spring had toppled to the ground in midstride; the hard sand showed a dark circle of moisture where her vases had shattered. Children had collapsed in their play, men in their work, females at their cooking fires. A shroud of silence hung heavily over them, and the aura it projected was leaden and deathlike.

They were a sensitive people, these Illesk; they kept birds and small animals as pets. But now the birds lay comatose in their cages; the animals lay wherever the evil breath had touched them.

Approaching the village from the sea was a fleet of tubby, oblong boats, each propelled by four oars. Beyond them, on the horizon, was the mother fleet, a cluster of humped-looking, two-masted, square-sailed luggers.

The invaders sprang into the water and waded ashore as the oared boats neared the beach. They carried weapons—a massive, clublike implement on one shoulder; short spears in their belts.

They were an ugly people: small, bow-legged, faintly purple-skinned. They swaggered into the village.

The first villager they happened upon was an Illesk fisherman who sat huddled in immobility, frozen in the act of mending his nets. As they passed him, one of the invaders swung his club. The fisherman's skull was crushed; brains and soft matter oozed onto the path. The invaders detoured around it, the only indication of sensitivity shown by them.

One of them veered aside to use a scattering of comatose children for target practice with his spears. Another bent over a stricken female and, aiming his strokes with care, clubbed her body into a battered pulp. They searched through the village systematically, and though they found no one who was not comatose, they continued to club and stab whenever the impulse moved them.

A second wave of boats trailed after them. These contained the scavengers; they carried bags rather than weapons, and they searched the village for objects of value. From a large building near the beach, several scavengers carried full bags to the boats and returned with more empty bags to be filled. The smokehouse also yielded a rich haul.

Finally convinced that they had looted all that was worth taking, they straggled back to their boats. Along the way, the warriors with clubs and spears indulged in passing target practice on inert bodies that had escaped their attention earlier.

"*Stop it right there, would you please?*"

The departing figures suddenly became as motionless as those lying on the ground, and one club, caught in a final act of head-bashing, was frozen in mid-swing.

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The official at the head of the table, whose title was chief inspector, but whose rank was so lofty that he called himself whatever he chose, asked incredulously, "Don't these characters ever encounter any resistance?"

Ward Cerril, Interplanetary Relations Bureau coordinator for this world of Harscone, waited politely for his sector supervisor to respond. Sector Supervisor Darlett always had all the answers—about everything—and never hesitated to supply them. On this occasion, however, his manner was strangely subdued. He had disagreed with Cerril about the world of Harscone, and Cerril had "gone over his head" and convoked this conclave. Regulations required that it meet on the world concerned and that it be made up of inspectors ranked at least grade one or higher. As a result, the sector supervisor, who was accustomed to being the highest-ranking IPR Bureau officer in a swathe of light-years, found himself outranked no matter which way he turned. He had lapsed into a totally unaccustomed silence.

Cerril, suddenly the center of everyone's attention, was enjoying it immensely. After carrying Harscone and its unsolvable problems on his own shoulders for two years, he had risked his career by calling this conclave, and he was delighted with the inspectors' reactions. "As far as we know, the Illesk are always rendered unconscious before a raid begins. The Zwaln, which is what the invaders call themselves, have never encountered the slightest resistance."

"Then these swaggering bullies never have to do any fighting? They just bash or stab unconscious victims while their fellows loot the place?"

"That is correct."

"What, exactly, are they looting?"

"Smoked dessik, a type of fish. It occurs only in offshore waters around the southern end of the large island of Yaron, and when cured with smoke from arroln bark—that's the kind of wood the Illesk use—it becomes a gourmet dish that would be famous on any world fortunate enough to have it. It brings a high price in continental markets, but I don't know whether the Zwaln sell all of it or eat some themselves.

"Another treasure the Zwaln search the dwellings for are the rulm, which are rare gemstones occasionally found on these beaches. They have a religious significance to the Illesk, and any they find are placed in the small family religious shrine that occupies a corner of every Illesk dwelling. Unusually large rulm are placed in the village shrine, which is that oversized structure near the beach. It is the first place the Zwaln loot.

"In addition, the Illesk are talented woodcarvers, and their abstract carvings have a religious significance for them. Some are placed in family shrines; the largest hold places of honor in the village shrine. The carvings bring very good prices in continental markets. That's as much as we've been able to figure out."

"Is there any enmity involved—traditions of racial feuding, anything like that?"

"None that we are aware of."

"And when the victims regain consciousness, how do they react?"

"As far as we can determine, the Illesk don't even know the Zwaln exist. They are already comatose when the Zwaln arrive; they remain comatose until long after the Zwaln leave, and they seem to have no awareness that they have been unconscious. They react to the carnage as though some natural catastrophe has struck their village—hurricane, tidal wave, some such irresistible force. They show the same stunned sadness that victims of an overwhelming natural disaster might display. They cremate the dead, travel en masse to a holy spring for purification ceremonies, gradually rearrange their lives—and begin building another reserve of smoked fish, collecting more rulm along the beach, and making new carvings for their shrines."

"In other words, they immediately be-

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gin to replenish their wealth so it will be ready for the Zwaln the next time they call," the chief inspector said dryly.

"You might put it that way, sir."

"And precisely what is it that you want the conclave to decide?"

"The regulations state four requirements for a conclave," the coordinator said. "An extraordinary situation, failure of all measures devised to deal with it, the urgent need for an extraordinary solution, and total disagreement as to what that solution should be. On the world of Harscone, only three of the four apply because we have been unable to devise any measure at all to deal with the problem. I recommended that this requirement be waived, and the referee who heard my appeal agreed with me.

"The difficulty is complicated enormously by the fact that the intelligent life-forms on this planet, while roughly humanlike in appearance, are still so different that no IPR agent is able to masquerade as a Zwaln, or an Illesk, or any other race. The tallest adult of the Harsconian races is a bit less than a meter and a half high. No IPR agent could mimic that unless we were to train children. We must find a way to get close enough to these people to learn what goes on. We especially want to know what renders them unconscious."

"What would happen if you somehow managed to train Illesk warriors who were capable of fighting back?"

"It might frighten the invaders off. Or it might infuriate them and provoke more slaughter than they perform now. More likely, the warriors would be rendered unconscious along with everyone else and it wouldn't make any difference. At present, the Zwaln seem to have an instinctive awareness of the amount of death a village can tolerate without crippling its productivity. If there were too many murders, there wouldn't be anything to loot when the invaders returned on their next sweep of this territory—which we think will be in two or three years. I'll point out that the Illesk are found only on this one short stretch of shore along the island of Yaron, and if the Zwaln ever shake that instinctive limitation on the amount of slaughter they commit, a single series of raids easily could render the entire race extinct."

The chief inspector looked around the table. "We agree that something must be done. The question to answer is whether the situation merits the drastic action you are suggesting. Your petition states that you wish to solve this problem by introducing a new species to the world of Harscone, and that would be a drastic measure indeed. Just what new species do you have in mind?"

Coordinator Cerril grinned impishly. "Us."

The suggestion had come from Linguist First Class Klarn Fornley, and he made it without any notion that he himself would be the new species he suggested. He was not and never had been a field agent. He was a quiet, middle-aged man married to his profession, and he had spent most of his service in base headquarters on various worlds, working in secluded cubicles to unravel the mysteries of local languages. On Harscone, he had spent untold hours listening to teloid cubes and studying and analyzing every uttered sound. As a result of this intense effort, the IPR Bureau now had a fair working knowledge of Illeskian and several other local languages. Despite his most intense efforts, however, the Zwaln language had largely escaped him. He had only recently reached the conclusion that this was not a failure on his part. A dictionary constructed from the speech of Zwalnian warriors was doomed to be brief. Their vocabularies were brief about everything except head-bashing.

On worlds where the native life-forms were relatively similar in appearance to humans, IPR agents mastered language, mannerisms, and every visible attribute pertaining to the natives, and they spent their careers living among them and

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studying them. That was impossible on Harscone.

The problem had been threshed over at staff meetings without result until Fornley, coming out of his linguistic haze long enough to grasp for once what the problem under discussion was, suggested that since they couldn't masquerade as Illesks, they should introduce a new species to the planet—themselves—and adopt the role of helpful neighbors.

Fornley was shocked when his suggestion was taken seriously, but so was everyone else. Within IPR ranks, only a specialist accustomed to concentrating on his own narrow field of endeavor would have ventured such a suggestion. The Interplanetary Relations Bureau marched under a banner that firmly pledged its dedication to supporting the customs and traditions of native peoples. Nothing that in any way interfered with their natural evolution and development could be tolerated. What the conclave had approved was not only irregular but unthinkable—so unthinkable, in fact, that once the approval was received, no one had the slightest notion of how to carry it out.

With much trepidation, the base staff set about planning the first contact of the new species—them—with the Illesk. At one meeting after another it failed to agree on the most critical question: Which agent should be entrusted with making that first contact? None of them had any experience at all in dealing with the worlds' natives.

Coordinator Cerril sat in on one of the interminable arguments and contributed a typically puckish decision. "The original suggestion was Fornley's," he said, "so why not have a linguist do it? A linguist should be better equipped for a first communication than anyone else."

Linguist First Class Klarn Fornley it was.

Now he plodded wearily alongside a four-wheeled cart that was pulled just as wearily by a cuddly, small-but-sturdy four-legged mountain animal. It came from such a remote and isolated mountainous area that the native peoples of Harscone seemed unaware of its existence. It had no name, so IPR personnel gave it one. It looked cuddly; therefore it was a cuddly.

The IPR Bureau had approved the introduction of one alien species, but it had no desire to impose an entire alien zoology on this world of Harscone. Everything associated with that unknown species had to be genuinely native. Its work animals, if it had any, had to have resided on the island of Yaron at least as long as the Illesk had. The products it offered for trade—members of the new species would approach the Illesk as traders—had to be authentic products of the flora and fauna found in mountain forests.

The Illesk had to be convinced that the new species had always been in residence in the inaccessible mountainous area that arose in the center of the island. Because the lofty mountains were objects of mystery to them, and because they themselves never ventured very far inland, it was hoped that they would accept IPR Bureau personnel as mountain creatures they had never chanced to meet. The cuddly, a most appealing genuine native mountain animal, should help.

So IPR agents had caught a herd of cuddlys—gentle, easily-taught creatures—and trained them to carry loads or riders and pull vehicles. The fabulous honey of an insectlike mountainous tree-creature would be unknown to the Illesk because it was found only at heights above 2,000 meters. One of the bureau's flying platforms was an excellent accessory for gathering the honey. Of course, there had to be a bit of cheating. A mountain clay made serviceable pottery, better than anything the Illesk had, but to achieve that, the IPR agents had to fire it in a special electric kiln. Shelves of Fornley's cart were filled with small crocks of honey, which Fornley

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hoped would be a high-demand item.

Seeds gathered from mountain meadows were ground into flour that made excellent bread. Again, cheating was necessary. The grain unfortunately was useless as a trade item because it would have taken the Illesk centuries to discover a suitable method of grinding it; the flour was no better because its bread failed unless just the right amount of yeast was used in mixing the dough. IPR agents met the problem by compounding a bread mix; flour with yeast already blended in so that all the Illesk females had to do was add water. The mix was sealed into crocks. A delicious-tasting dried meat from a rodentlike creature whose fecundity previously had made it a nuisance completed Fornley's stock. IPR Bureau personnel pronounced all of these items highly edible. What the Illesk would think of them remained to be seen.

One more thing was needed—a *pièce de resistance*, some kind of gift that would overwhelm the natives. An IPR agent invented a form of candy made with honey and dried mountain fruits. Those fruits had seemed sourly inedible, but blended with the honey, they formed squares of a delicious candy. If the first contact went well, Fornley could bestow candy on the entire village in parting.

Finally the moment was at hand. Fornley's stock and equipment were ready; he earnestly hoped that he was ready.

As in all of their activities, the Illesk practiced sound ecology in their harvesting of trees. They seemed to take every third arroln tree, so that they were actually giving a forest a healthy thinning, rather than stripping it. Then they dug a shallow ditch that could serve as a chute and waited for the rainy season to slide the logs down to the beach. There the bark was stripped off and stored for smoking fish; the remainder of the log was trimmed into firewood.

As a result of this activity, a network of well-worn paths led up the slopes from every Illesk village and into the forest. Another path led to a series of lookout posts established at vantage points along the coast. Watchers stationed there searched the sea constantly from noon to sunset for movements of the dessik, whose schools were easily spotted by their leaping and by the throng of flying predators that pursued them. The dessiks' own favorite prey, a small fish normally found in shallow water near the shore, moved farther out to sea when the surface water became sufficiently warmed, which it usually did by afternoon, and the dessik moved shoreward to feed on them.

Illesk villages occurred about twenty kilometers apart along the southwest, southern, and southeast coasts of Yaron. This roughly approximated the offshore range of the dessik. The Illesk communicated with each other only by sea; none of the natives would have thought of walking to the next village.

This was awkward for an IPR agent. The Illesk may have been childlike, but they weren't likely to swallow the proposition of mountain creatures who had never been near the sea suddenly becoming seagoing traders. Somehow the traders had to move their stock of goods from village to village. Working quietly at night, IPR agents built a "trader's road" and surfaced it with native gravel. It lay far enough inland from the coast so that the Illesk were unlikely to happen onto it. From that road, paths connected with the network of Illesk paths above each village, thus giving the traders ready access to the beach.

It took months to complete all of these preparations. In the meantime, Fornley had preparations of his own to make. He had to decide how to approach the Illesk. If the seemingly gigantic Fornley were to casually lead his cart and cuddly down the slope and into a village, the Illesk almost certainly would consider them creatures from the nether regions and take to the forest. There had to be some kind of preparation for his visit.

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Fornley began with the northernmost village on the western coast of Yaron, and his first objective was to waylay one of the watchers. Watchers worked alone, staring at the sea, and might enjoy a bit of company. Late in the day, when they would soon be returning to the village, he quietly led cuddly and cart to the edge of the forest near one of the clifftop lookout stations.

"Harlk!" Fornley called, using a common Illesk greeting. The watcher turned and immediately registered consternation.

An Illesk, Fornley reflected, could be beautiful only to another Illesk. The same could be said of the Zwaln. Both races were short and bowlegged, with stooped bodies. The Zwaln had purplish skin; the Illesk, faintly greenish skin. The faces of both races looked like flattened circles, and the features seemed hurriedly sketched in as though their creator had been in a rush to finish. Their heads were hairless; in compensation, the remainder of their bodies was well enough endowed with black hair to almost—but not quite—seem furry. Their clothing consisted of loose robes that could have been called wrappers.

As far as the Illesk were concerned, something similar could be said of Fornley, who was hideously distorted in size, with sharply-formed features and all his hair in the wrong place. No wonder the watcher began backing away. Since he was backing toward the cliff, Fornley immediately feared for his life.

"I come in peace," Fornley assured him hurriedly. "I am a trader." This last word was his own invention. The Illesk language offered no equivalent. Apparently no one traded on Harscone, at least in the outlying regions. Instead, they somehow rendered the other party unconscious, bashed him on the head, and took what they wanted.

The watcher was not convinced. Since Fornley had remained motionless, he stopped backing away, but he continued to scrutinize the gigantic invader warily.

"Come and sample my wares," Fornley suggested. From the cart he took a crude wooden table and two chairs—all well within the scope of Illesk technology—and arranged them as though preparing a tea party.

"Come!" he said again. "After a long afternoon of watching, you have both a hunger and a thirst!"

He turned and opened his charcoal oven. This simple contrivance, roughly fashioned of wood—and therefore within the capacity of the Illesk—and lined with clay, was an IPR Bureau master stroke. The delightful aroma of fresh-baked bread filled the air. The watcher stumbled toward the cart almost in spite of himself. With an Illesk knife that used a sea shell for a blade, Fornley cut off a chunk of bread, smeared it with honey, and offered it with a smile.

He prepared a similar chunk for himself and took a bite. "Delicious!" he exclaimed.

The Illesk took a small, tentative bite and chewed cautiously. "Delicious!"

They were friends. They sat at the table drinking fizz, a drink IPR Bureau personnel had concocted from an assortment of mountain herbs and named fizz simply because it was fizzy, and munching bread and honey. They talked about life in an Illesk village. Fornley, who of course was recording every word the Illesk uttered, turned the conversation to subjects likely to interest a member of a mountain species who had never seen the sea. He listened raptly while the Illesk described dessik fishing and the smoking and cooking of these fish.

Time passed. The cuddly, who had found a cluster of wild flowers he liked, munched contentedly. The watcher, who called himself Arvit, suddenly realized that dusk was descending and he was long overdue at the village. Fornley suggested that he accompany him and meet the other villagers. No doubt they would enjoy sampling Fornley's bread and honey. Arvit agreed, and they strolled along together, continuing their

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conversation. Fornley neglected to mention the fact that several IPR Bureau agents were following close behind them, prepared to intervene if events took an unfavorable turn.

When they reached the steep slope down to the village, Fornley tactfully suggested that Arvit go on ahead and prepare his fellow villagers for a visit by a giant. "All of my people look like this," Fornley confessed. "We have hair on our heads, and we are almost unnecessarily large. We can't help that, but we try to trade honestly and be good friends and good neighbors to those who are good friends and good neighbors to us."

Arvit agreed. He hurried down the slope. One of Fornley's IPR escorts, who had been watching and listening to the first contact, slipped forward and asked Fornley, "Is it really going to be this easy?"

"I can't say," Fornley said. "They certainly seem to be a friendly people."

"As long as the honey lasts," was the other's cynical suggestion as he faded back into the trees.

Fornley started cuddly and cart on the steep descent and found the entire village drawn up and waiting for him. Arvit first presented Fornley to Larvot, a wizened old male who was the chief village elder. Perhaps because of his age, he was almost bald all over. He wore his lofty status with great dignity, and he greeted Fornley with friendly curiosity.

Fornley, with equal friendliness, removed two freshly baked loaves from the oven and tried to explain what a trader was. The bread, with honey, was an instant hit. So was the fizz. So was the cuddly, with the children. It was even more of a success than the honey, so Fornley unhitched it and led it on circuits of the village with clusters of child riders clinging to it.

Then he showed the females how to make bread with the crocks of bread mix. They quickly learned to add water, knead the dough, and set it aside to rise. The results were placed in their own crude and massive ovens and baked with enormous success. Illesk bread had previously been a thin, tasteless crust.

Finally came the ceremony of trading, and it took Fornley some time to get the idea of equal values across to the natives. They gladly would have given him all that they had for a few crocks of honey. He exchanged his entire stock of honey, bread mixes, and fizz powder, loaded the cart with smoked dessik, and promised to visit them again soon. He had a last word with Arvit, and arranged for the watcher to meet him the next morning and walk down the coast with him to introduce him to the people of the next village.

As a parting gift, he produced the candy and gave a piece to everyone in the village. It caused a sensation.

It was late when he left the village. Climbing back up the slope from the beach, he couldn't believe that everything had gone so easily. He said as much, via his communicator, to Coordinator Cerril.

"The test will come when you try to explain the Zwaln to them and persuade them to work on defense measures against a danger they don't know exists," Coordinator Cerril said.

The next morning, with cart resupplied by platform during the night, Fornley turned off the Traders' Road expecting to meet Arvit just above the village. He was not there. Fornley waited; finally he tied up the cuddly—he saw no point in forcing the creature to pull a heavy load down to the village and then back up again—and went to see what the matter was.

The first thing he noticed was the smokehouse—the fire had gone out. There were no cooking fires in the village. No males were at work; no children at play; no females to be seen anywhere.

He broke into a run and looked into the first house he came to. To his horror, all the inhabitants lay on their sleeping mats, apparently dead in their sleep. He managed to convince himself that they

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were still just barely breathing, but the entire village was as comatose as it had been during the Zwaln's visit.

Fornley's shout brought his escort of IPR agents scrambling down the slope. While they checked every house in the village in search of one conscious inhabitant, Fornley sent an urgent message to base asking for medical personnel.

An hour or so later, the Illesk began to come out of their comas—the young and middle-aged first, then the elderly, finally the children. As they regained consciousness, they were astonished to find a number of giants around them—giants very similar to the one who had entertained them the night before, but these giants were grave and curious in all kinds of intimate ways, looking into their mouths and nostrils, listening to their stomachs with odd-looking contraptions.

The base doctor told Fornley, "If I encountered symptoms like this in any species of animal I'm familiar with, including humans, I would say that the patient had been drugged. All of them seem to have gone to bed about the same time; no one got up. What did the entire village ingest simultaneously that knocked everyone unconscious?"

"They'd had bread, and honey, and fizz. The entire IPR staff has thoroughly tested all of those things, but of course that may mean nothing with an alien people. More to the point, they ate those things all evening and were in excellent health right up to the moment when I left them."

"Then it was something they ate just after you left them."

"That I don't know anything about. Except—" A horrible revelation struck him. The candy!

After an intensive chemical analysis, the culprit proved to be a cherrylike fruit that had been dried and candied along with the other wild fruits. The IPR staff had tried it with no noticeable bad effects. A small sample had knocked out the entire population of an Illesk village for a night and part of the next day.

"They must have extremely sensitive stomachs," was the doctor's verdict. "Don't serve them any more candied cherries." He reflected for a moment and added, "Doesn't something like this happen just before a Zwaln raid? Perhaps there's a traitor in the village who sneaks a drug into the community soup kettle."

"There isn't any community soup kettle," Fornley said. "Anyway, the doping that accompanies a Zwaln raid wasn't anything like what they experienced with the candy, where they went to bed and drifted into an unusually sound sleep. When the Zwaln drug hit them, they were energetically doing their usual daily chores, and everyone was frozen in midstride."

The doctor shrugged. "However it is, we now know that there are native products that have a narcotic content, and the natives, or some of them, are affected far more powerfully than we humans are. Just don't treat the Illesk to any more candied cherries. By the time the Zwaln come again, you'll have the answer, I'm sure."

That candy was so memorable that the Illesk of the first contact village continued to ask about it for months afterward. Each time they asked, Fornley invented difficulties and changed the subject.

He resumed his program of making himself and his products known in all of the Illesk villages. With an introduction from Arvit, he repeated his success at the next village and moved southward and then eastward along the coast, always persuading an Illesk from the last village to introduce him. His activities kept the IPR base in dessik, which quickly became everyone's favorite food, and also kept IPR base personnel working furiously to keep him supplied with honey, flour, dried meat, and crocks of bread mix.

The world of Harscone consisted of one vast continental land mass, where scattered populated areas had become centers of wealth and primitive civilization. These were the markets where the

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Zwaln disposed of their loot. The continental history seemed to be working out the way most such histories did. The rulers were hereditary tyrants, sometimes wise but more often stupid and self-indulgent, and the IPR Bureau evaluators had reluctantly concluded that it would be centuries before workable democracies could be achieved.

The formidably mountainous island of Yaron was a distant sea journey from the continent, and the Illesk must have discovered it in the dim past when they were more of a seafaring people than they were presently. They had liked the place, settled, and in a modest way prospered. The large island was still unpopulated except for the strip of beach the Illesk occupied around the curving coast of the southern part of the island.

Once settled there, the Illesk had remained undiscovered almost to the present because there were no other seafaring peoples until the Zwaln began their forays.

Arvit's and Larvot's village, the most northern settlement on the west coast, was the one the Zwaln were most likely to reach first when they made landfall after crossing the ocean. Something had to be done to protect the gentle Illesk the next time the Zwaln arrived, and at IPR base headquarters, lengthy discussions were being held to decide what that might be.

At the moment, none of this was Fornley's concern. His trading route quickly became more than he could handle, so he turned segments of it over to other IPR Bureau agents. All of these traders became popular characters in the Illesk villages, and—while the coordinator and his staff were losing sleep over the problem of how to deal with the Zwaln—the traders were enjoying themselves immensely.

When Fornley finally was summoned to base, he found the interruption irksome. He had done what they asked him to do—make a first contact. He had gone beyond that and now he was extending it into a permanent contact. He wanted to be left alone to finish the job. What he did not want were more problems to solve.

"There wouldn't be any difficulty in monitoring a Zwaln fleet, would there?" he asked irritably when the coordinator raised the problem of protecting the Illesk from the Zwaln. "I mean, no one else comes to Yaron, and the Illesk never leave it except for offshore fishing. You should be able to predict the next invasion precisely."

"I agree. We should be able to do that," Coordinator Cerrill said.

"As a seafaring people, the Zwaln must already have a sizable literature of myths and fables and the like. All we have to do is give them one more—the alarming news that Yaron has become a land of giants."

The coordinator nodded slowly. "Yes. We can do that. But the giants must make a lasting impression, or the Zwaln will keep coming back. On the other hand, slaughtering the Zwaln is not what we want."

"A stun gun with the vibration set at low level should produce enough blisters to make the giants memorable. A thoroughly blistered Zwaln wouldn't be in any hurry to return."

"Yes," the coordinator mused. "Yes, that might be a lasting deterrent. When they arrive to loot a village, you want them met by a giant with a stun gun—is that the plan?"

"I think the giant should be far more terrifying than even an unusually tall IPR agent would seem to them. Let's say an IPR agent on stilts. And perhaps his stun gun could be modified to produce unusually large and lasting blisters."

"Yes. That's a good thought, Fornley. We will see what can be devised." He paused. "I wonder, Fornley, why you never tried field work before."

Fornley said wearily, "I wouldn't be trying it now if I weren't such a good linguist."

* * *

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The world of Harscone probably had no active native astronomers, which was fortunate. Otherwise, even the most primitive skywatchers would have been given cause for superstitious concern when the IPR Bureau launched a satellite over the Western Ocean. Ship traffic was monitored, and the base's attention was quickly drawn to a group of uninhabited islands. Since no one knew the native name for them, they were dubbed the Crossroads Islands.

They were literally that. Ships headed from the continent to southern islands or vice versa invariably stopped there for water and fresh meat from the hordes of birds that made the islands home—a fact that indicated how limited the navigational range of Harsconian ships was. Their sea voyages were, essentially, island-hopping. Only the Zwaln took voyages long enough to reach the island of Yaron, but they could be expected to replenish food and water at the Crossroads Islands before they headed east.

IPR base headquarters made its plans accordingly.

While base was studying shipping routes, Fornley was studying the Illesk. His problem was to determine the best way to stage a drama in which the Zwaln were confronted by giants and permanently frightened away from Yaron.

Should the Zwaln be permitted to make their usual raid and be met by the giants in a village in which all of the villagers were comatose? Or should the Illesk be removed from the village and permitted to watch from a distance? And if they were removed, would the Zwaln suspiciously remain in their ships, or would they land anyway and attempt to loot an empty village?

Although the Illesk knew nothing at all about the Zwaln, Fornley reasoned that they must have *some* explanation for the periodic looting of their villages and the slaughter of substantial numbers of inhabitants. He had to find out what it was.

In making his trading rounds, he frequently enjoyed a lengthy chat with Larvot, the chief elder of Arvit's village. The old Illesk found Fornley's intense interest in everything about the Illesk and their beliefs flattering, and in Larvot's eyes Fornley gradually achieved the status of a somewhat dull favorite student.

At their next meeting, Fornley turned the conversation to the Illesk gods, something Larvot seemed reluctant to discuss.

"Do you make sacrifices to the gods?" Fornley asked. It was a fumbling question; Fornley had no idea what the correct word for "sacrifice" might be.

He got no reply, so he changed the question. "Do you give your gods gifts?"

Larvot seemed more puzzled than before. "The gods take their gifts," he said.

"Take them?" Fornley mused. A great light dawned. "You mean—they come here to the village and take them?"

"They do, but we don't consider them gifts. They are payment owed them for making the weather kind and the dessik numerous. They come and take their payment and punish those who have offended them."

"Do they punish even children?" Fornley asked.

"That they do."

"But what could a mere child do to offend a god?"

Larvot raised his hands despairingly. Perhaps this was a subject the natives themselves had pondered. Larvot may have lost a favorite child or two of his own.

"Among my people there is a saying that youth is the gift of the gods," Fornley said. "Perhaps, having given such a gift, the gods feel that they have the right to take it back."

"But what would the gods need it for?" Larvot demanded.

"To give it to others," Fornley suggested.

"Yes, yes . . ." Larvot mused. "To give it to others. Youth, like life, is ours for a

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time and then must be passed on."

Fornley decided to change the subject. Somehow he had managed to justify the Zwaln when the opposite was his intention.

"When do these visits occur?" he asked.

"In the morning. Always in the morning."

"And what do the gods look like?"

Larvot was shocked. It was impossible to see a god. No one had ever seen a god.

"Even so, you might better understand your gods if you were able to watch them collecting payments and administering punishments. I don't know whether this would be possible. We have our own gods who seem to be much more benevolent than your gods. They don't exact payments and they don't punish children. They are friendly and easy to converse with. If the idea pleases you, I will ask our elders to find out what our gods can tell us about your gods, and their punishments, and their collection of payments due."

After some hesitant protests, Larvot finally agreed that Fornley should ask his elders to speak to those friendly gods about the Illesk gods.

Having come that far, Fornley decided not to rush things. He didn't mention the subject again until Larvot did. Then he explained, gravely, that evoking the gods was a risky business and had to be done at the gods' convenience. Even then, something that had happened a long time before might be beyond the gods' reach, but he would try. As soon as he had anything to report . . .

When finally he did, the entire village plus the populations of three neighboring villages gathered to watch. To heighten the mystery, Fornley and two IPR assistants built a gigantic bonfire on the beach. The night was still with very little breeze, and when Fornley tossed a bag of chemicals onto the fire, the thick, white smoke went straight up.

The smoke provided an excellent background for a teloid projection, and the villagers sat in rapt silence and watched the powerful magic evoked by the giants' gods. The projection they saw was the same scene that had fascinated the IPR Bureau conclave.

The Illesk were awed into immobility. Only rarely did their emotions move them to break their silence: A female seeing the death of two of her children; a male seeing his wife battered to a bloody pulp; even old Larvot, seeing the death of a favorite grandchild.

The teloid ran to the end; the thick white smoke faded. The stunned audience did not stir for some time. Finally old Larvot managed to speak. "It is powerful magic indeed that your gods possess."

"Powerful indeed," Fornley agreed. "Only a powerful and very special magic could make the past visible to us. Now you have seen with your own eyes the proof that the gods of this world are kindly and have nothing to do with collecting payments from you and inflicting punishments on you. That is the work of a sly, unprincipled people from across the water who have found a way to render entire villages unconscious so they can rob and murder at will. Think about what you have seen, and then we can take counsel about what might be done to stop it."

They did take counsel, and long before it was time for the Zwaln to make another raid, Fornley's plan had been completed and rehearsed repeatedly.

The longer Fornley worked with the Illesk, the fonder he became of them. They were so childlike that all he had to do was make a game of something, and they entered into it with wholehearted enthusiasm.

So Fornley made a game of the Zwaln invasion and showed the Illesk how the Zwaln could be frightened away by Fornley and two of his colleagues masquerading as giants. The ingenious conversion of the freakishly tall traders into

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fire-breathing monsters enraptured the Illesk, and they gleefully anticipated the reaction of the Zwaln. They even entered enthusiastically into rehearsals for the evacuation of their villages during which entire populations would take refuge in the forest.

The Zwaln's fleet was tracked—first to a stop at the Crossroads Islands to replenish food and water supplies; then in an eastward turn toward the island continent of Yaron. Everything was ready for it. It remained only to predict the exact day.

The night before the anticipated landing, a dozen villages along the west coast were evacuated and their entire populations moved to makeshift shelters in the forest, except for a few stalwart males who remained behind to keep the fires going and make the villages look normal. Fornley didn't believe the Zwaln would have time to raid a dozen villages in one morning, but neither did he know where they would start, so he evacuated twelve to make certain he got the right ones.

It was still dark when he took his waiting position at the edge of the forest and stood looking out to sea. He knew that just beyond the horizon was a fleet of ships, perhaps with landing craft ready to be launched. There was no sign of them. The exact time of their arrival was uncertain except that it would be after the villagers had their breakfasts and began the day's chores—firing up the smokehouse, splitting logs for firewood, getting their fishing equipment ready in case a school of dessik was sighted later that day. The village's watchers would not take up their positions on the cliffs until early afternoon, which may have been one reason why the Zwaln always came in the morning.

The haze of early dawn still hung over the village—normally, everyone would still be sleeping—when a single four-oared Zwaln landing craft came into view. It made its tedious way toward the beach. Fornley exchanged glances and shrugs with the IPR agents waiting with him. This was new. This was unexpected. This might even be highly important, but he could not say how. Fornley and the other agents drew back into the trees and watched.

The boat contained only the four oarsmen and a passenger. As it neared the beach, the passenger stepped into the surf, gave the boat a shove to get it reversed and headed out to sea, waved nonchalantly, and quietly splashed his way shoreward.

If the Zwaln noticed anything suspicious, he gave no indication of it. He marched through the village looking straight ahead, turned aside once to glance into the smokehouse—the caretakers already had a good fire going there—and then quietly headed into the forest.

"Get him!" Fornley hissed.

The other agents, each of whom was far larger than the Zwaln, seized, trussed, and gagged him before he knew what was happening. Fornley got busy with his communicator and learned that four more abandoned villages were also having an early morning visitor.

"Grab them!" he ordered. "Tie them up. Gag them."

He asked the agents working with him, "Was he carrying anything?"

"Tinder-box of some kind. Contains several different granular materials—perhaps they produce different colors of smoke and can be used for signaling. This, plus a large bag full of what looks like nuts."

"Emergency rations?" Fornley suggested.

No one knew. All Fornley could determine was that every village marked for invasion that day had an early morning visitor, five of them in all, and all of those visitors were carrying tinder-boxes and bags of nuts.

"Eventually, we will find out what those things mean—if they do mean anything," was Fornley's exasperated verdict.

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Their captive, who was seeing the gigantic IPR agents for the first time, was terrified. It could be read in his eyes. Eventually they would have to decide what to do with him; for the present, Fornley's worry was that this advance invader had some important chore to tend to. His duty might be to send a signal when everything was ready, and if no signal came, the Zwaln waiting at sea might abort the invasion. Or perhaps the invasion would come if the advance agent did nothing to call it off. Fornley was left wondering whether he should have watched the invader to see what he did, rather than capture him; but if the Zwaln had caught a single glimpse of an IPR agent or sensed that the village had been abandoned, he certainly would have called the invasion off if he had the power to do so.

Fornley took one of the nuts, studied it, cracked it, and inspected the kernel—which did not look or smell edible—and decided the problem was one for the staff botanist. As for the tinderbox and its contents, that had to be left for later when there was no longer any danger of Fornley accidentally sending a signal of his own. He turned his attention again to the empty sea and resumed his worry about what might or might not happen.

Suddenly the Zwaln fleet arrived. The scene that was already familiar to them from teloid projections gradually took shape offshore, with a fleet of square-sailed ships giving birth to clusters of four-oared landing craft. The landing craft made their way tediously toward the beach.

Fornley and two volunteer agents arranged themselves to wait. To the invading Zwaln, they probably would look like piles of discarded clothing. Only when the invaders hit the beach would those piles evolve into towering monsters.

The Zwaln stepped into the water and splashed ashore. Immediately they began to show signs of puzzlement—there were no victims in sight, no villagers lying about whose heads could be bashed or whose bodies could be used for spear practice. Suddenly all the fun had been taken out of looting a village.

Fornley began the much-practiced maneuver that would transform him from a pile of discarded clothing to a giant. He rose to sitting position—he already wore the hideous mask that had been designed for him—and gradually assumed his full, normal height, which was gigantic enough to the Zwaln. Pneumatically-operated stilts slowly elevated him another three feet. Nearby, two more piles of discarded clothing were likewise undergoing transformation. When the Zwaln began to recoil in horror, Fornley displayed an ingenious special effect and blew a long tongue of fire at them.

They were too terrified even to flee. After more blasts of fire from all three of the agents, Fornley turned his stun gun on them. Not even that acute discomfort brought the Zwaln to their senses. They remained petrified until the three monsters started toward them. Then they turned and made a panicky retreat to the boats.

But not to flee—not yet. The seagoing bullies were not entirely without courage. They had come a long way, in creaky boats, and they wanted some profit from the trip. They did not give up at once. They moved down the coast to the next of the already-selected victim villages, where the scenario with performing giants was repeated. Again they moved farther along the coast to meet a third trio of fire-breathing giants. After that, with the invading warriors thoroughly blistered, the Zwaln fleet sailed north to an unpopulated stretch of coast, where they came ashore to replenish their water. Then they disappeared westward, abandoning their advance agents and leaving a delighted Illesk population in possession of both its treasures and its lives. It left the IPR Agents with the perplexing problem of

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what to do with the five Zwaln agents, their tinder-boxes, and their bags of nuts.

The Zwaln agents were turned over to the Illesk for safekeeping. Fornley presented the five bags of nuts to Ev Hilder, the IPR botanist, who recognized them at once. "There's a family of nut trees spread through the southern islands," he said. "That's the same neighborhood the Zwaln come from. The natives call the nuts zwaaf nuts. This is a variety I haven't seen before. Some of the nut trees are genuine oddities with foliage that looks like hair, but trees and nuts vary considerably from island to island. On some of the islands, the nuts are fed to domestic animals. I've seen no indication that people eat them, but of course that is a possibility. Each to his own taste, eh? As far as I know, they are used only locally if they are used at all. The natives don't seem to trade them, so they're unknown on the continent. Maybe it's a matter of no one wanting them. I'm glad to have a new variety to study. Is there anything urgent about it?"

"It's more a matter of curiosity, I would say."

"Isn't everything?" Hilder moaned. "I have about ten thousand requests on my desk that are matters of curiosity. This one is more interesting than most—odd-looking things, aren't they?"

"They don't look or smell edible," Fornley observed.

"And you didn't carry the experiment to its logical conclusion and taste them? That was wise. Some of the things native animals eat would be poisonous to us—not fatal, perhaps, but capable of producing a monstrous tummy ache. Eventually I'll get to them and give you a report."

The riddle of the tinder-boxes was quickly solved once the danger of inadvertently sending an unintended message was removed. The boxes contained five different substances, and each sent up its own distinctively colored smoke—red, blue, yellow, white, and black. They would have to wait for another invasion to see how the Zwaln reacted to different colors.

Fornley, along with all of the agents who had taken part in the operation, conferred with the coordinator to decide what to do next.

"It depends," Coordinator Cerril said, "on whether the Zwaln are cured permanently of their desire to bash heads, or whether they will be back in a few years to see whether the giants have gone away. What are your thoughts?"

"The Illesk are developing into quite competent traders," Fornley said. "The cost of smoked dessik, measured in terms of crocks of honey or flour mix, has gone steadily upward. I would like to further their education to a point where they would be able to stand on their own two feet—hold their own in a general trading situation. To do that, they would have to get their smoked fish and gemstones and carvings to market. They aren't accustomed to seafaring out of sight of the coast, and they know nothing about navigation. If we were to teach them to make a half-ocean journey—to the Crossroads Islands, for example—and if we were to establish a trading post there where other peoples, including the Zwaln, could bring their products and trade them, we would make an invaluable contribution to this world's development, and the Illesk would take a giant step forward—from bewildered victim to a partner in this world's affairs."

The coordinator grinned at him. "You like those people, don't you?"

"I do," Fornley confessed. "I would like to see them do well."

"It seems that we are becoming more and more directly involved in the lives of this world's inhabitants," the coordinator said. "That is something the Interplanetary Relations Bureau has strictly avoided in the past, and I'm not sure that such a drastic change of policy is a good thing. I'll submit your proposal for review, and you can go ahead with the

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planning and see what action might be required."

Fornley went back to the Illesk to try to describe an ocean voyage to them—and made a horrible discovery. Each of five villages—the five where the Zwaln had sent an advance agent ashore—had a new shrine. The shrine's central object was a grinning Zwaln skeleton. Nearby was a wall-hanging fashioned quite artistically of purplish Zwaln skin. The gentle Illesk had flayed the advance agent and then plunged him into boiling water to convert him into a skeleton—all of that while he was alive, of course, though he didn't long survive the treatment. Now they had made his skeleton and skin the subject of an anti-god or devil cult, his fate being a warning to other devils to stay away.

Fornley told himself ruefully that he should have anticipated it. The Illesk were simple, but not stupid. The advance agents were linked to the murderers of their friends, and families, and perhaps ancestors further back than any of them could comprehend. They had taken their revenge on the only Zwaln within reach.

But now the specter of their nightmares had been exorcised. They themselves had seen how three giants—three of those nice if strange-looking people who traded with them and who played with their children—had frightened the Zwaln away merely by looking at them. Their shrines were intact; they had a huge surplus of dessik for trading. It would be a prosperous year.

Fornley set about preparing them for journeys to the Crossroads Islands where they could trade with other peoples. IPR agents knowledgeable in marine matters were brought in to teach them to build ships that were larger and more seaworthy that anything they had previously achieved. The Illesk had plenty of wood and the skill to build anything. All they needed was a suggestion or two at the right moment.

Then there had to be geography lessons to show the Illesk their place on the world of Harscone, how far the oceans extended, and where other peoples were located.

On Fornley's next visit to base, Coordinator Cerril had an answer for him. Fornley's suggestion had been reviewed by every headquarters all the way to Supreme, and every one had approved it.

The coordinator seemed both surprised and pleased. "Amazing," he murmured. "The Interplanetary Relations Bureau is usually such a rigid, regulations-bound organization. But the situation on this world was so unusual that several higher headquarters are watching it with interest. Congratulations!"

In advocating the Illesk experiment in the first place, the coordinator had stuck his neck out; probably it was a relief for him to know that now no one was likely to cut it off. There were too many heads involved. Instead, he would emerge from this difficult situation on Harscone with considerable credit to his record.

Fornley returned his attention to the establishment of a trading post. Since the IPR Bureau had no direct contact with any people on the planet except the Illesk, he decided to build the trading post first and let the world's trade come to him. The Crossroads Islands were a regular watering and provisioning point for everyone engaged in ocean travel. If a structure the native peoples hadn't seen before suddenly appeared there, their curiosity should do the rest.

At base, Fornley designed a fortlike prefabricated trading post—they couldn't take a chance on sea pirates like the Zwaln staging a raid—and it was erected on a day when the Crossroads Islands had no other visitors. The next callers would find the trading post already there with an assortment of goods available. They would carry the news to all of the places they touched on their way home, and that, Fornley earnestly hoped, would attract other traders.

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To Fornley's amazement, establishing the trading post went as easily as did his first contact with the Illesk. A ship from the continent, en route to the southern islands, put in at the Crossroads for water. Captain and crew were astonished at the strange building that had materialized there. Fornley, with an adequate backup in case of emergencies, met them on the beach, held another tea party, served bread and honey and fizz, and impressed his visitors with the bread mix and the portable oven. The Illesk had been taught to mass-produce the ovens, thus adding a whole new dimension to their economy.

Fornley traded an oven and crocks of honey, bread mix, and fizz powder for jars of native wine. Actually, it was a miserably poor excuse for wine. No IPR agent would drink it if he could avoid it, but the natives seemed to like it. The wine went onto the trading post's shelves to be offered to the next visitor. Having given the visiting captain a lesson in trading, Fornley sent him on his way.

A second ship arrived, was startled to find the trading post, and relieved to learn that no charge was made for water. Fornley achieved another success, and cases of reasonably good porcelain ware went onto the shelves. So it continued. After an Harsconian month, which was twenty-four days, Fornley had a warehouse of varied merchandise, and he had sent several flying platforms back to base packed with items needed there. Entirely apart from its noble objective of helping the native peoples, Fornley's trading post seemed likely to show a profit.

The next step was for each visiting ship to display samples of its wares and trade directly with another ship or ships. This became possible when the islands began to attract six or more ships at once. Fornley charged a modest port fee and let them trade with each other. His own native products continued to be popular, and no ship left without a stock of them.

This was the situation when one of the new Illesk ships sailed proudly into the islands' main harbor. Fornley knew the captain and the whole crew and greeted them warmly. (The IPR advisor who accompanied them remained discreetly out of sight.) The captain with a group of assistants began touring the displays of merchandise set out by the other ships. As it happened, there was a Zwaln ship in the harbor at the same time, and Fornley braced himself for trouble; but all minds were intent on trading and nothing happened.

Then Fornley's noble experiment ended abruptly—at least as far as he was concerned. It had come to the attention of someone in the sector supervisor's office that linguistic questions concerning the world of Harscone were not being dealt with. Sector Supervisor Darlett fired a tart query at Coordinator Cerril asking why his linguist was not performing and whether he should send a replacement. Fornley's special assignment was terminated abruptly. He told himself life was like that, asked his assistant to let him know how the Illesk made out with their trading, and sneaked away on a platform that night.

At base, he found his desk buried in urgent requests and queries, and as he began dealing with them, he made the interesting discovery that linguistic problems became much simpler when one had recently been speaking the languages concerned. He had always worked alone in the most isolated quarters a base could offer—he detested interruptions. He had been completely happy with that before his work with the Illesk, but after such a vital experience, his old workrooms seemed isolated and unreal.

These philosophical speculations were interrupted by a knock on his door. It opened a crack, and botanist Ev Hilder stuck his head in. "Can you spare some time? I'd like to show you something."

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Fornley contemplated the pile on his desk, which still covered two-thirds of it, and shrugged. He was weeks behind; what did an hour or two matter? "Sure," he said. "The sector supervisor is threatening to replace me because of this backlog, but his headquarters is a long way from here."

"Sector supervisors never know what's important," Hilder said, leading him back to his own workrooms.

Hilder's office contained ranks of teloid cube cabinets, a pair of teloid projectors, and a small table. His work rooms and two large greenhouses adjoined it. He got Fornley seated at the table and took the opposite chair. "I have a little experiment I want to show you," he said nonchalantly. He lifted a brazier onto the table. There was charcoal burning in it. "This might be better done outside with an ordinary wood fire," he added. "Since that isn't practical at our altitude, I'm doing it inside with charcoal."

Beside it he placed what looked like an ordinary tabletop air filter and set the automatic controls. Then, from a locked container, he took—counting them as he did so—four zwaaf nuts. "Recognize them?" he asked.

"Zwaaf nuts, aren't they?" Fornley asked. "What sort of a tabletop experiment can you perform with foul-smelling nuts?"

"Someone raised the question of what the nuts would be like roasted," Hilder said. "So we found out." He placed the nuts in the brazier, arranging them carefully on the charcoal.

As the nuts became warm, they emitted a mild stench that Fornley found vaguely familiar. It quickly changed to a pungent aroma when the shells charred and began to burn. The room took on lavender tints as thin smoke filled it. Fornley breathed deeply. . . .

He was floating in space; or perhaps he was adrift in a lighter-than-air balloon, though it was strange that he could see no balloon. *Something* was buoying him aloft with a delightful floating sensation. He saw colors—rich, vibrant colors. He experienced incredible pleasures, as though his nerves were strung like a harp and someone or something was stroking them and bringing forth a dazzling mix of sounds. His head spun with an exhilarating inebriation. Suddenly he wanted to leap . . . to leap . . . to leap . . . to fly away. He extended his arms. . . .

The blast of cold air hit him like a shower of ice as the air filter sucked in the brazier's smoke; the room quickly cleared.

Fornley exclaimed, "Great mumbo jumbos and abracadabras! What is that stuff?"

"The chemists and the medical people are working on it now," Hilder said. "The consensus is that your innocent zwaaf nuts would sweep all of the galaxy's other addictive drugs off the market if we turned them loose. They contain some hallucinogens that are unknown to science. Of course, no one has the slightest idea what the long-term effects might be. Probably bad. The only certain thing is that this drug, or combination of drugs, can provide the most pleasant and addictive high known. Light beginning to dawn?"

"And how!" Fornley breathed. "A whole lot of things suddenly fall into place. When a Zwaln agent landed at a sleeping Illesk village, the first thing he did was check the smokehouse to make certain there was a good fire going. The Zwaln raided only at a certain time of year and at a certain time of day. We wondered why. The reason was that they needed a good offshore wind—one that would carry the smoke from the smokehouse down through the village. At the agreed time, and I never thought to check on how the Zwaln tell time, their agent sneaked a hefty ration of zwaaf nuts onto the smokehouse fire. The offshore wind carried the fumes through the village and anesthetized the entire population. But why weren't the Zwaln affected when they landed?"

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"The effects on someone who has inhaled a good jolt of the smoke last for some time after the smoke fades. No doubt the Zwaln had that reduced to a science. They could land after the smoke thinned and loot the village effectively before the Illesk came out of their drug coma; and then, as they prepared to leave, their agent tossed another ration of nuts onto the fire, thus making certain that none of the Illesk regained consciousness until the Zwaln fleet was out of sight."

"Right." Fornley took a deep breath. Already he felt a strange craving for the exhilarating buoyancy he had experienced. He took another breath and felt strangely disappointed that he could catch no whiff of zwaaf nut aroma. "The question now is what should be done. These nuts may prove to be incredibly valuable to science in some ways we are too stupid to imagine, but obviously we'll have to take strict control of them. Just for a beginning, we must make certain none are smuggled off this world—which may be an easy task as long as the only spaceships calling here are IPR ships."

"Perhaps not as easy as you think," Hilder said. "Haven't you wondered why I keep the nuts locked up? There may be IPR agents who are bored and would like to give their lives a fantastic jolt of pleasure. I'm not going to take the chance of starting a fad of drug jags. Sitting on high explosives is a mild exercise compared with sitting on this stuff. I've sworn all those working on it to secrecy."

"Do we let the Illesk know what it was that rendered entire villages unconscious?"

"I think not," Hilder said. "You said they remembered nothing at all of the experience. Better leave it that way. We'll have to get a firm grip on the situation before the Zwaln tumble to what a treasure they have."

"Have you told the coordinator?"

"Not yet. I have a long conference with him scheduled for this afternoon. I'm not looking forward to having to inform him that this world could suddenly blow up in his face."

"Very well. We won't tell the Illesk what made them unconscious. We'll have to learn more about the Zwaln, if their island is where the nuts come from, and take steps to keep them there. If worse comes to worst, we might transplant some nut trees or bushes to plantations where they can be studied under strict security, and eliminate the zwaaf nut trees in their natural habitat."

"It wouldn't be all that easy," Hilder said. "You're still hallucinating. For one thing, we have no idea how widespread the native sources are or where they are. For another, exterminating a species would require the approval of at least two dozen committees and every headquarters between here and Supreme. But that's my problem. Carry on with your trade center. I'll worry about the nuts. Except—I want you to take a pledge of secrecy, too."

Fornley did so.

He returned to his own office, wearily looked at the accumulation on his desk, and wondered how the IPR Bureau could extricate itself from this problem. Fortunately it was no longer his problem. An assistant came in waving a slip of paper.

"From the Crossroads Islands," he said. "Word about the Illesk traders."

"Yes. I asked to be told how they made out."

"Apparently they made out very well. No one ever saw a prouder and more delighted trading crew. They certainly 'landed on their feet,' as you put it, and held their own when trading with other peoples."

"I was wondering what products would interest them."

"The message said they traded their entire cargo of smoked dessik for a ton and a half of something called zwaaf nuts." ■

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THE REFERENCE LIBRARY Tom Easton

Toys A to Z: A Guide and Dictionary for Collectors, Antique Dealers and Enthusiasts, Mark Rich, Krause Publications, $19.95, 480 pp. (ISBN: 0-87349-240-4).

Mad Melancholy Monkey Mind: Drive (music CD), Iguanodon Smile (P. O. Box 971, Stevens Point, WI 54481, www.iguanodonsmile.com), list $10.97, website price $9.

A Paradigm of Earth, Candas Jane Dorsey, TOR, $26.95, 366 pp. (ISBN: 0-312-87796-X).

The Impossible Bird, Patrick O'Leary, TOR, $25.95, 365 pp. (ISBN: 0-765-30337-X).

The Rock Rats, Ben Bova, TOR, $24.95, 385 pp. (ISBN: 0-765-30227-6).

Captain Nemo: The Fantastic History of a Dark Genius, K. J. Anderson, Pocket, $23, 357 pp. (ISBN: 0-7434-4406-X).

Creations of Fire: Chemistry's Lively History from Alchemy to the Atomic Age, Cathy Cobb and Harold Goldwhite, Perseus, $18, 475 + xvi pp. (ISBN: 0-7382-0594-X).

Dorsai Spirit, Gordon R. Dickson, TOR, $25.95, 430 pp. (ISBN: 0-312-87764-1).

Expecting Beowulf, Tom Holt, NESFA Press (Box 809, Framingham, MA 01701, www.nesfapress.com), $16 (+ $3 s&h in US, $5 foreign), 365 pp. (ISBN: 1-886778-36-1).

You are reading this in summer warmth, but it is still frigid January as I write this. Boskone—the major Boston-area SF convention—is next month, but for a change I couldn't wait. So I went to my first Arisia (also Boston) last weekend, and it was both familiar and strange.

Strange? A con's a con, after all, but Arisians spend a lot more time in costume than Boskonians. Leather and chain mail (yes, *that* chain mail accessory of which you have heard; surely a bit too chilly for trips onto the street in January). Swords, blinking headgear, elevated bodices, and big floppy hats. And dealers catering to as many tastes as they can find.

There was even one for me: "The Realms Finest" sells elegant leather masks, and I could not resist buying one. If you wish to see what tempted me, their web site is at www.therealmsfinest.com.

Familiar? What is a con without panels? I sat on three devoted to various aspects of science and technology, and I had an excellent time. My fellow panelists were well chosen and knowledgeable, and the audiences were interested and responsive.

A strange mix? Well, maybe, but science-fiction folk are an eclectic lot. If you doubt me, consider *Analog* contributor Mark Rich (his "Dumptown" was in the February 2002 issue). He's a toy historian with regular columns in a couple of collector magazines, and last year he published **Toys A to Z: A Guide and Dictionary for Collectors, Antique Dealers and Enthusiasts**. It lists toys, games, mottoes, and companies, along

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with appropriate illustrations, some with enough SF connection to justify me in finding a shoehorn to fit the book in here (such as the Captain Video game on p. 84, the Space Cruiser pedal car on p. 306, the 1930s-era Buck Rogers outfit on p. 327, and the Atomic Disintegrator on p. 480). If toys are your thing, this is your book.

Rich is also a musician, and his band—Iguanodon Smile—has just released its first CD, **Mad Melancholy Monkey Mind: Drive** with a cover pic that looks like it started life in Rich's toy collection. The music isn't really much to my taste, but there are samples on the website—go see if it suits you better.

Candas Jane Dorsey's excellent and thoughtful **A Paradigm of Earth** begins with a sad case of depression. It is bad enough that the world is stressed by population and greenhouse warming, turning conservative and conventional. Gays have it rough once more. AIDS victims get no sympathy. Health insurance gets ever more expensive and covers less. And here is Morgan, working with pediatric surgical cases. But one dies. Her lover leaves. Her father dies, and her mother promptly piles her car into an abutment.

When the will unexpectedly leaves Morgan a big old house in Edmonton, she chucks everything and relocates. She is "a fugitive from the war with life." She has wounds to nurse, and she feels that she wants nothing more than to retire from the hurly-burly, renovate the old manse, and take in a few boarders to help cover the expenses.

That's when the aliens arrive with a nice big ship, nice blue skin, and a baffling message: "To learn from you," says the one that visits the UN. "Yes. That is the assignment. Earth is needed to know. So one is sent to know Earth. [But] to find out from this one is not to happen. This script is complete, and will erase. Do not erase the recording you make. This bodies will stay. It will not much known. But to learn and take knowledge back. An assignment." Whereupon the alien collapses. Instant infant. *Tabula rasa*.

And Morgan spots an ad for a child care job. Since she needs money, she responds. The "child" turns out to be one of the aliens, and when it responds to her, giving itself the name "Blue" on the spot, she has the job: coach and teacher, mentor and guide, parent, if you will. The alien learns quickly, soaking up all of Earth she and the teams of experts in nearby rooms can deliver. It is clearly recapitulating a developmental process, growing up much like a child, and in the process capturing much more of humanity than any fully individuated adult possibly could.

Is Blue picking up a bit too much? There's a body or two, and no one is quite sure Blue isn't responsible. But they carry on anyway, until Blue is finally developed enough to run away from home much like a rebellious teenager. The alien winds up on Morgan's doorstep, and soon she has another boarder, along with a security team in a new garden shed.

Now Blue is exposed to a very different set of people—Delaney, John, Jakob, and Russ, all artists of various sorts. Blue learns a new set of lessons, and before long it is turning into a rather nice sort of guy (or gal—the anatomy is ambiguous). Blue is also turning out to have some interesting talents, such as telepathy.

As for Morgan, Blue seems to have been just what she needed. She is now engaged with her world, with Blue, with the security folks who keep the public away, perhaps especially with their chief, whom she calls Mr. Grey and with whom one soon senses a growing bond. She is surfacing from her depression, even as Blue nears the time when it must leave, returning to the mother ship to be read out in some way to some vast data store.

Will the aliens actually learn much

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from their living record of "humanness"? Dorsey seems skeptical, on the grounds that Blue is so human that the aliens must need some sort of interpreter, just as they would if they were interrogating a human. But the idea she offers makes a great deal of sense: Aliens who could provide a Blue (and the other alien "blanks" scattered around the world) must know what they are doing; they will learn something from whether any Blues survive at all, or from their condition; beyond that, Blue seems quite real and very sympathetic, but is surely some sort of construct designed to have all its experience on Earth downloaded or replayed in some virtual theater.

Did Morgan learn anything? The novel ends with her reflections on just that question. Suffice it to say here that her depression is gone. She is reconnected to life. A future beckons.

Is it the sort of future we might see in a sequel? I don't think so, but Dorsey has done such a superlative job of developing Morgan and Blue that I regret saying that. This is the sort of book that one puts down a bit wistfully, reluctant to say goodbye to the characters but knowing that their time for us is over.

You've seen novels in which characters were dead, but never a thing quite like Patrick O'Leary's **The Impossible Bird**. The chief characters are Danny and Mike, brothers who in 1962, lying on their backs in a wheat field, see something that might be a UFO pass overhead and never notice the wheat around them go from summer ripe to fall stubble in a breath. Forty years later, Dan is a literature professor in mourning for his late wife, hardly able to function except for caretaking his son, who has the strange idea that hummingbirds tell true about how magic words can make all whole. Mike is a producer of TV ads just wrapping up at a jungle shoot. A native has a hummingbird in his hand, and another calls it "A miracle. To catch the impossible bird." A black helicopter appears overhead.

What does it all mean? Neither Dan nor Mike has a clue. Memory is a bit foggy, and it doesn't get any less so when Mike returns to the States and is kidnapped by three men who want his bird. He's baffled, since he doesn't have one, but it won't be long before he learns what bird they mean. First, however, he must be rescued by people who seem to think it a sacrament to shoot each other. And then he is told, "If you want to live, find your brother."

Meanwhile, Dan's son is missing, and at the door is an agent of the NSA, who wants him to find Mike—if he wants to see the boy again.

So the mutual hunt is on, with a great many surprises in store for both the characters and the reader. Mike and Dan will reencounter Dr. Klinder, who hypnotized them as children and now is fighting a war against those who like killing people. He's on the side of the hummingbirds, you see, and they indeed do believe in magic words. Remember the right one, and all becomes clear. You remember your own death, understand the hummingbirds, and embrace your karma.

It's magic realism more than SF or fantasy, though it has elements of both the latter. It's different, and it's readable.

I didn't review Ben Bova's *The Precipice* (nor its audiobook version) because it had already been serialized here. But here's the sequel, **The Rock Rats**, and it's fair game.

It opens at the wedding of Amanda and Lars Fuchs, when the villainous Martin Humphries—who would twirl mustachios if he had them—gifts them with the *Starpower 1*, the test ship for the fusion drive that figured so greatly in *The Precipice*. Go to the Belt, he says. Be prospectors and stake claims and get rich. Even though—here he chortles to himself and twirls at least a mental mustachio—the ship is already obsolete and

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the newlyweds are doomed to failure. He *will* get Amanda into his clutches, by golly!

Except it doesn't work quite that way. Lars and Amanda become suppliers of food and parts and other necessaries, and as was learned long ago on Earth in Gold Rush days, storekeepers get richer than prospectors.

So Humphries gnashes his teeth and plots a scheme to take over the Belt. He sets up a competing shop, sends out hired company prospectors, and puts a killer to work scaring off the independents. The good guys try to complain to the authorities back on Earth, but they seem to be in the villain's pocket. It is up to Lars to arm a ship and hie off to fight.

"No!" cries Amanda, but Lars has become a driven man. Soon he too will be a killer, hunted and trapped and brought to . . . justice? Amanda is given a chance to save her husband, but the price is high.

There is more, but this is the gist. The plot is musty and quaint, the characters stereotypes, the dialog stiff. Bova has done better in the past, and surely he will again. But first he must finish this one: Like *The Precipice*, *The Rock Rats* ends without closure. There must be at least one more volume to the series.

Breathes there a soul that never read any of Jules Verne's *voyages extraordinaires—Twenty Thousand Leagues under the Sea*, *The Mysterious Island*, *Five Weeks in a Balloon*, *Around the World in 80 Days*, *Journey to the Center of the Earth*, and many more—or saw one of the movies based on them? Could any such soul fail to wish to know more of some of the characters Verne sent on his adventures? And could any character stir such longing more than the mysterious Captain Nemo of the submarine *Nautilus*, star of *Twenty Thousand Leagues*?

Of course not, said K. J. (a.k.a. Kevin J.) Anderson, and he rubbed his hands together, fired up his steam-powered word processor, and began **Captain Nemo: The Fantastic History of a Dark Genius**. André Nemo and Verne were boyhood friends, he tells us. Of the two, Nemo was the adventurous, inventive one. Verne was something of a tagalong sidekick, just a bit reluctant, and certainly too slow and bashful when both boys fell in love with young Caroline Aronnax, daughter of a wealthy merchant.

Nemo's father is killed when a ship he is working on explodes. The boy is penniless and too young to fend for himself, but Caroline helps him get a position on a ship bound on a voyage of exploration.

"Moi, aussi!" cries Jules, and they are off down the Loire until Verne *père* catches up and hauls the boy home for a beating. (The historic Verne did try to run away to sea, with the same result.) Nemo continues, learns, grows, and when the ship runs afoul of pirates is the sole survivor—on the island that, says Anderson, was the model for *The Mysterious Island*. Not only that, but he writes down the tale of his adventures, tucks it in a bottle with a message that if found it should be delivered to Verne, and tosses the bottle into the South China Sea.

And when the pirates show up again, he discovers a passageway to a realm within the center of the Earth and winds up in Iceland.

You get the idea. Nemo has adventures that provide Verne—once Verne hears of them—with the germ of each novel. Meanwhile, Verne is pursuing the life documented in his biographies. His father is pushing him relentlessly toward a career in provincial law, but the young man is enchanted by the Parisian scene and yearning desperately for the literary life modeled by his mentor, Alexandre Dumas. He is writing plays and seeing them performed. But he is not finding success. His time will come, but only when he accepts the gift of ad-

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venture Nemo gives him in his bottled manuscripts and occasional in-person reports.

Yet Anderson has done more than play such a simple game. There is Caroline, with Nemo gone for years and presumed dead. Much to Verne's disappointment, she marries a Captain Hatteras, who promptly sets sail and never returns. When Nemo does return, she is a married woman, unattainable—although, if he is patient, seven years must pass in due time. While waiting, he hies off to the Crimean War, takes part in the Charge of the Light Brigade, and is kidnapped along with a corps of engineers and shipbuilders by Caliph Robur, who wants a submarine warship with which he can restore the ascendancy of the Ottoman Empire.

The task seems doomed, for Nemo and his men must invent the technologies needed for the job. It takes years, during which Nemo takes a wife and has a son. But in time, the *Nautilus* is real. All Nemo must do now is escape the Caliph, vanish for a year until the political turmoil dies down, and return for his wife and son.

But we know from Verne that the Nemo of the *Nautilus* was a bitter, lonely man. Something awful must be about to happen to make Nemo not just a hero, but a tragic hero and a scourge of all those who make war upon the seas.

All I will say is that the final ending does have a bit of the fairy tale to it. Anderson has done a very nice job that will surely add another best-seller to his groaning shelf.

Cathy Cobb's and Harold Goldwhite's **Creations of Fire: Chemistry's Lively History from Alchemy to the Atomic Age** is very much what its title promises. It's lively because, though it covers the basics of chemistry itself, the focus is on the people who created the science. It reaches back well beyond alchemy, noting that some 100,000 years ago, people had a basic grasp of certain practical chemistry-based technologies (e.g., pottery and paint). Within a few pages, the authors move through basic, primitive metallurgy to the ancient Greek philosophers who developed the rudiments of chemical theory (e.g., Democritus and atoms). The story becomes more current and more familiar with the 1700s, by which time the scientific method was helping out and chemists had a glimpse of underlying patterns to be sought. By the 1800s, some of those patterns were in hand and chemists were beginning to see how to make new substances, something we take as routine today, even when those new substances are genes and the result is a transformed organism—a whole new kind of alchemy.

Do you have kids in high-school? As promised, this book will add a human dimension to what strikes many students as a very dry topic. It could also be an invaluable reference for writing term papers.

NOTABLE REISSUES

In 1959, Gordon R. Dickson began his never-completed Childe Cycle in *Astounding* with "The Genetic General," later published as *Dorsai!* Thus began the "Dorsai" series, which extended through many more stories and novels, including *The Spirit of Dorsai* (reviewed here in March 1980), *The Chantry Guild* (May 1989), and *Young Bleys* (September 1991). The tales varied in success, but the overall design was admirably ambitious. Dickson had in mind an epic of the Responsible Man (and Woman), the far-sighted rationalist who works for the good of humanity as a whole, versus the Selfish Man, the short-sighted rationalizer who works solely for his own gratification. He had fragmented the human character into three of its prime modes, reason, faith, and intuition, and given each its own world or worlds, that of the strategically and tactically adept Dorsai, those of the religious-fundamentalist Friendlies, and

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those of the mystical Exotics.

"The Genetic General" or *Dorsai!* introduced a world of supremely competent and responsible mercenaries, and it is one of those tales that one remembers fondly and rereads happily. *The Spirit of Dorsai* is a pair of novelettes that emphasizes the character of those members of the Dorsai people who do not serve as mercenaries. If you want to try them out, they're both in **Dorsai Spirit**. So get a copy!

While you're at it, get a copy of **Expecting Beowulf** too. Tom Holt is a marvelously zany, witty writer whose gifts show in all their glory in *Who's Afraid of Beowulf?* (reviewed here in November 1989) and *Expecting Someone Taller* (May 1991).

Beowulf opens when a survey crew breaks into a Scots barrow and calls in archeologist Hildy Frederiksen. She climbs into the tomb, finds a very well preserved longship (complete with weaponry, treasure, and a dozen Viking "corpses"), spooks, and flees. Then the "corpses" awaken and the fun begins.

Expecting starts off when nebbish Malcolm Fisher hits a badger with his car. The badger promptly reveals itself as Ingolf the Frost Giant, ruler of the world, possessor of the Tarnhelm and the Ring of the Nibelungs. "So here, Malcolm. Take 'em. You got me, fair and square, and to the victor go the spoils. The cap will let you turn into anyone or anything or take you anywhere you wish. The ring—rub it, and you're rich. But do watch out for Wotan, Alberich, and the Rhinedaughters. They *all* want it back."

Have fun! ■

Hubbert's Peak:
The Impending World Oil Shortage
By Kenneth S. Deffeyes
Princeton University Press, $24.95 hc, 208 pages, ISBN: 0691090866

Supplemental book review
by Richard A. Lovett, Ph.D.

In 1956, an oil-company geophysicist named M. King Hubbert predicted that U.S. oil production would peak in 1972. The industry scoffed, but Hubbert was close to the mark: the actual peak came in 1970.

Deffeyes, a former colleague of Hubbert's, has now applied the same analysis to the world as a whole. That peak, he says, will come sooner than most people expect—sometime between 2004 and 2009. We won't run completely out of oil that soon, but prices may go through the roof.

Hubbert's Peak divides into two parts. The core is an analysis of production and discoveries, based on the presumption (with some empirical support) that both follow bell-shaped curves. The remainder is a primer in petroleum geology, oil exploration, and drilling, dedicated to the proposition that we shouldn't expect a quick technological fix. Yes, there are undiscovered oil fields, and yes, there are ways to increase the amount of oil extracted from existing ones. But the industry, Deffeyes says, has been working on these problems for generations and "there is little expectation that something dramatic will come riding to the rescue."

Whether you believe Deffeyes will depend on your willingness to accept statistical extrapolations. But even if the specifics prove wrong, this is an important book. My only quibble is with its reliance on extremely simple prose to convey complex ideas. That can backfire by making discussions seem simplistic and by obscuring the logic that links one thought to the next. Nevertheless, *Hubbert's Peak* is an entertaining read, decorated with anecdotes and humorous asides, written by a man who clearly loves both geology and teaching. Its conclusions gain credibility by coming from an industry insider. ■

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BRASS TACKS

Dear Stan,

I enjoy most of the stories in the magazine but occasionally you have one that it is based on a false premise. Even though I like "Hominids," it falls into this category. It is based on the idea that criminal or evil or bad behavior is in the genes, as Ponter says on page 123. That doesn't wash at all. It may seem possible that people there don't commit crime because they are afraid of the consequences, but that doesn't work either. It's possible that the final segment will bring this out, but if not, I would like to write to the author.

The cause of behavior that is socially unacceptable or harmful in some way is caused by a malfunction in the brain which is the result of brain damage caused by stress of some kind—mental, physical, emotional, or a combination thereof. Many brain scientists have found this correlation through their research that shows "functional voids" in otherwise mentally healthy people.

I still like the story. I am able to suspend this knowledge temporarily because it's well written, but I would like to see a story about alternate worlds that brings this out.

By the way, the brain damage can be completely healed through the Transcendental Meditation technique and other programs from the Vedic literature. (The Vedic literature is the "book of instruction" for the human body. Following the guidelines and principles results in perfect physiological functioning—perfect health.)

Laurence Topliffe

* * *

The author replies . . .

I'm sure that Mr. Topliffe is absolutely sincere in his beliefs, but there are, of course, countless geneticists, psychologists, neurobiologists, and criminologists—and even a few lowly science-fiction writers like me—who simply don't share his opinion. Ah, well. To each his own.

Robert J. Sawyer

Dear *Analog*,

I haven't even finished reading the second installment of Robert J. Sawyer's "Hominids" yet, but I just have to comment on it. So I'm writing my first ever letter to *Analog*.

I'm enjoying every moment of the novel. But it's on the quality of his research that I'd like to commend Mr. Sawyer (I have no idea where he's from). What actually prompted this letter happens on page 107, a passing remark on Mike Harris, the Premier of the Province of Ontario.

Though in no way essential to the story, the mention is right on the money. Premier Harris is rather stingy and has in fact shut down or merged many Ontario hospitals (the French community in Ottawa in fact just a few weeks ago finally won a years-long legal battle with the provincial government over the shutting down of the Montfort Hospital, the only French-speaking hospital institution in the Province and a major training hospital for francophone physicians).

Weaving that into my mind gives that much more credibility to all his re-

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search; if he managed to get that detail right, unimportant to the story that it is, imagine what he did for the essential parts, like Neanderthal genetics and the history of species. (I'm not a scientist myself and often lack the critical knowledge to be able to evaluate the science in science fiction.)

Of course all this falls a bit flat if it turns out Mr. Sawyer is Canadian and living in Toronto; but I'm still very much enjoying the story. And before my balloon gets burst I have to say it: Canadians just aren't used to that level of knowledge of the Canadian reality from south of the border. It's a nice feeling once in a while.

Francois Ferland
Chicoutimi, Quebec

Dear Mr. Easton,

In your March 2002 column, you said: "'Belief is no substitute for critical thinking.' If you are religious. . . that statement has to be offensive."

Okay, yes, I do take offense a bit. Not at the words you quoted, but at your conclusion that, if I'm religious, I must automatically have a knee-jerk negative reaction to a quote that, in actual fact, I find quite valid. I don't know what religious tradition(s) you've been exposed to. In mine, though, belief and critical thinking are seen not as antagonists but as partners.

In high-level terms, one of our basic tenets is that science and religion are in essential harmony. Tools to help us study, understand, best survive in, and glean the most from being part of the physical and spiritual Universe. Science that ignores religious values evolves into a monstrous master; religion that ignores scientific values devolves into base superstition. "Belief is no substitute for critical thinking." I agree. And in like manner: "Critical thinking is no substitute for belief." That's why they're partners. To be human is to need both, each in its proper place at its proper time.

I enjoy your columns. I even wrote to you once before to thank you for one of them. So please, if you want to give me fair warning that I might be bothered by something, that's one thing. Don't tell me I will, though; let me decide for myself. Thank you.

Lucki M. Wilder
Chicago, IL

Mr. Easton replies . . .

Fair enough. I should have said "that statement may be offensive."

Dear Dr. Schmidt:

Your March 2002 editorial was, I think, one of the best demonstrations of the difficulty, if not futility, of communication between those from a God-centered, "religious" (especially Christian) point of view, and those with a Man-centered Darwinist/reductionist/rationalist point of view when it comes to moral or ethical issues. Your musings raised many questions and observations of my own. Herewith a few:

This "humanity" that you mention—of what is it composed? How is it measured? Indeed, what "proof" is there that such a quality exists at all in any physical, measurable sense? What is the threshold amount of "humanity" beyond which a human is considered human by those in the Man-centered relativist scientific community?

So, a zygote, or a blastula, or a gastrula is a "potential" human. I assume you mean that because it doesn't possess a significant "humanity" quotient it is somehow other than or less than human. A fertilized egg is one cell with forty-six chromosomes. We are many cells with forty-six chromosomes. How many divisions does it take before the "potential" becomes realized?

As for the biological frontier, I have no doubts that your predictions and more will come to pass. What is the difference between cloning an embryo specifically to harvest certain parts, like the stem cells, and cloning an embryo for the later harvesting of other parts, like hearts

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and livers? You and I may dislike the practice, but what right do you or I have to judge the conduct of those who will provide that service or those who will benefit by it? The simple fact of the matter is that, quoting Erwin Lutzer, it is "... scandal beyond irony that when men throw off the disciplines of revealed religion, their freedom ends in slavery. Religious tyranny must, of course, be abhorred; but when mankind uses its coveted freedom to disown God, a worse tyranny follows." Or, as stated otherwise by Dostoyevsky, "When God does not exist, everything is permitted."

John Jarrell
San Antonio, TX

Stan,

Regarding the bioethics of cloning, the only argument against it that approaches validity is that a human being is created at conception. The difference between a chimpanzee and a human, supposedly, is the human soul, which appears at conception. To my mind, that argument falls apart. In the case of identical twins, there is the moment of conception and appearance of the soul. Then the one-celled human divides into a two-celled, one-soulled human. Those two cells separate to independently grow into individuals. Who got the soul? And where did the second one come from? Or did each get only half a soul? Or is one soulless?

Like you, I have no answer for these questions, but my inability to answer does not mean that others with more passionate beliefs should prevail. I hope, perhaps unrealistically, that the religious beliefs of some do not dictate scientific policy.

Bob Allen
Richland, Washington

Dear Sir,

I enjoyed and was pleased to see your March 2002 editorial "Musings from the Bioethical Frontier." I am a long-term, avid reader of this most interesting magazine and look forward to the science fact sections each month, in addition to many of the stories. Permit me to comment, as a developmental neuropathologist and physician of forty years, with a background in obstetrics, on your remark: "Life, they say, begins at conception . . . I don't think anybody denies that life begins that early." In fact, that is totally wrong. Life began millions/billions of years ago, at a time, in a place, and under essentially unknowable conditions. Animal conception, yes, and human conception too, provides an opportunity to restructure life, but *it occurs by the fusion of already living cells!* These are not hibernating desiccated spores from intergalactic space; they are living cells programmed and provided by living tissues.

D. Radford Shanklin,
M.D., F.R.S.M.
Memphis, Tennessee

Dear Stanley,

I have been reading *Analog* editorials for a long, long time. So long that I vaguely remember one of your predecessors arguing that there are no such things as "rights." There are only privileges that we have collectively forcibly wrested from the state's self-protective tendencies towards totalitarianism. I think that may have been John Campbell. Anyhow, I found those arguments persuasive, so the answer to your question is that you or I do not have a "right" to reproduce by cloning or any other methods.

I was going to criticize your comment on life expectancy and population growth until I reread it. You are, in fact, correct about the relationships among life expectancy, birth rate and population growth. The part about pollution and other unpleasantries is, however, a technology/policy issue, and not at all as inevitable as you infer. Countries, as they develop, have all made pollution control a priority, for the simple reason that it has a positive payback in reduced

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health-care costs and lost productivity.

The real story of interest here, however, is that population is actually declining in nearly all economically-advanced countries and most of the countries of the former Soviet Union, though for different reasons in the latter. Japan, Italy, Germany, etc. are going to be much smaller countries fifty years from now. The USA is growing only due to immigration, for the rate of natural increase has been negative for quite a while. This poses some challenges for education and assimilation, but poses no cultural issues since we think of ourselves as a country of immigrants. For the Japanese, Germans, and others that are very ethnocentric in their concept of nationality, it is going to get quite ugly as the population ages and the ratio of retirees to workers soars.

William S. Darter

Dear Editor:

Re: *Analog* March 2002, "The Human Genome Results."

"Those with better designed skulls . . . will have an edge over other bats. They'll smash into fewer trees and catch more fleeing mice."

Why would a bat wish to catch a mouse? Perhaps the author was thinking of owls.

I enjoyed the article, anyway.

Karen Stauffer

* * *

The Encyclopedia Britannica *indicates that some of the 900 or so species of bats are carnivorous or fish-eating, so there may well be some that hunt mice. However, you're right that most species live on insects (and one group likes fruit).*

Dear Dr. Schmidt,

In "Brass Tacks" (March 2002) you asked for information on EO13166. The costs to all of us as taxpayers and consumers will be extremely large. OMB has been directed to give a report to Congress by 3/01 on costs and benefits. I suggest you check www.englishfirst.org for a large number of links and email baguilar@omb.eop.gov for preliminary cost estimates.

The executive order requires all federal agencies, states, other government *and private* entities (including nonprofit) that receive money from or sell to the federal government to provide service in *any* language requested. Currently that would be about 300, but could grow to 3,000! So far, neither President Bush nor Congress has had the guts to cancel this horrible legacy of President Clinton. (It was done at the same time as the questionable pardons.) There is probably a web site for U.S. English, as well as for English First, but I have not found it.

Alwien Dierl ■

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UPCOMING EVENTS Anthony Lewis

September is usually a sparse month as fans recover from the World Science Fiction Convention held on or about Labor Day weekend.

29 August–2 September 2002
CONJOSE (60th World Science Fiction Convention) at McEnery Convention Center, et al., San Jose, CA. Guest of Honor—Vernor Vinge; Artist Guest of Honor—David A. Cherry; Fan Guests of Honor—Bjo & John Trimble; TM—Tad Williams. Registration—$180 (EUR200, CAD285, AUD350, GBP125) until 31 July 2002, more at the door. (These are the latest rates posted on the Internet as of the time this column went to press.) This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition—the works. Info: ConJose, Box 61363, Sunnyvale, CA 94088-1363; email—info@conjose.org; URL—www.conjose.org

31 October–3 November 2002
WORLD FANTASY CONVENTION (Literary-oriented fantasy convention) at Hilton Minneapolis and Tower, Minneapolis, MN. Guests of Honor—Dennis Etchison, Jonathan Carroll, Kathe Koja, Stephen Jones, Dave McKean. Registration—$120 in advance, more at the door. Supporting membership—$35. Banquet—$50. Info: World Fantasy Convention, c/o DreamHaven Books, 912 West Lake Street, Minneapolis, MN 55408; phone—1(612)823-6161; email—wfc@dreamhavenbooks.com; URL—www.dreamhavenbooks.com/wfc.html

28 August–1 September 2003
TORCON 3 (61st World Science Fiction Convention) at Metro Toronto Convention Centre, Royal York Hotel, et al., Toronto, Ontario. Guest of Honor—George R. R. Martin; Artist Guest of Honor—Frank Kelly Freas; Fan Guest of Honor—Mike Glyer; TM—Spider Robinson. Registration—$145 (CAD 220) until 1 January 2002, going up thereafter, even more at the door. (These are the latest rates posted on the Internet as of the time this column went to press.) This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition—the works. Info: Torcon 3, Post Office Box 3 Station A, Toronto, Ontario M5W 1A2, Canada (remember postage is $0.60 from US to Canada); email—info@torcon3.on.ca; URL—www.torcon3.on.ca

Convention runners: If your convention has a telephone, FAX, email, or Web page URL, please let us know so that we can publish this information.

Convention attenders: When calling conventions for information, do not call collect and do not call too late in the evening. It is best to include a S.A.S.E. when requesting information; include an IRC if the convention is in a different country. ■

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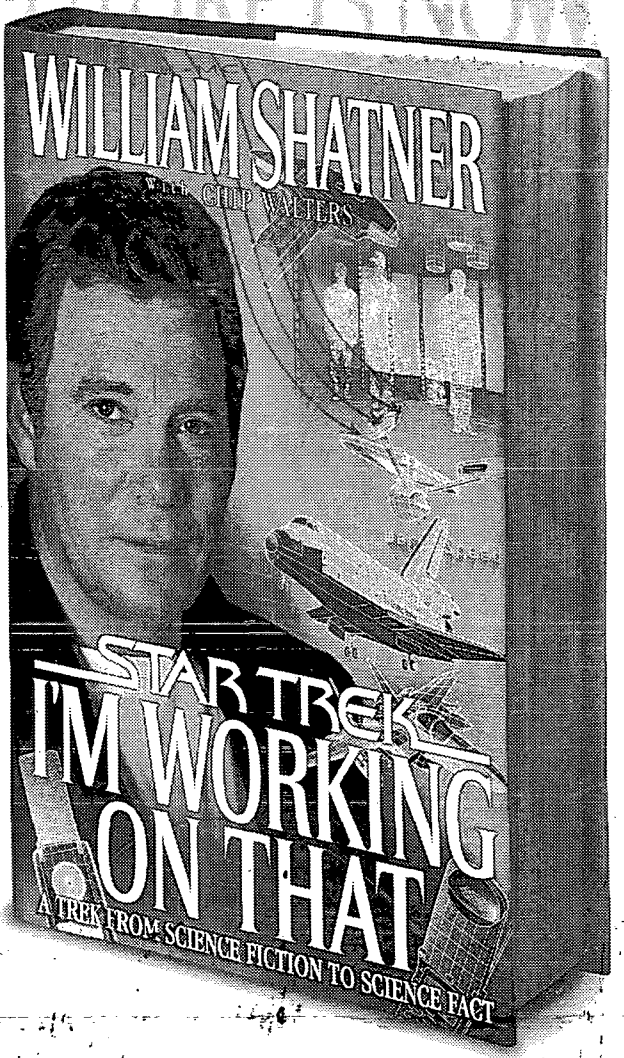

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